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Conseil Permanent International pour l'Exploration de la Mer

CHARLOTTENLUND SLOT — DANEMARK

ANNALES BIOLOGIQUES

VOLUME NO. XIV

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1957

En Commission chez

ANDR. FRED. HØST & FILS

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Février 1959

Scheme for the Arrangement of the Material

I. Review of Investigations and Essential Results

Each Committee Chairman should here give a summary of the contributions received, i. e., a statement of the nature of the material as well as a short review of the position in the area—including the main results obtained—during the last calendar year (unless otherwise stated). This review should only in exceptional cases exceed 2 pages (about 10,000 units of type). Papers should reach the General Secretary not later than 1. May.

II. Tables and Conclusions

A. Environment

1. Strength and direction of currents: Especially data collected during spawning seasons.

2 a. Temperature and salinity conditions: Tables and/or diagrams including anomalies.

2 b. Seasonal temperature variations at selected stations: Data including anomalies.

3. Phosphate concentration, oxygen, etc.: Tables and diagrams to include anomalies.

4. Plankton conditions: Tables and/or diagrams, especially anomalies in distribution of indicator forms, phytoplankton patches, amount of plankton and fat content.

5. Abundance of benthonic food: Data.

6. The main meteorological features of the year: Data especially as to sunlight, rainfall, and direction and force of the wind.

B. The Fish

For each species in the following order: Gadoids (cod, haddock, saithe, others), flatfishes (plaice, dab, flounder, sole, witch, lemon sole, halibut, others), herring, sprat, mackerel, other pelagic fishes, eel, redfish, others.

1. Abundance and distribution of eggs and larvae.
2. Abundance of year-classes: Data derived from experimental hauls
3. Size- and age-composition of commercial catches or landings.
4. Average length of age-groups: Data from experimental hauls and commercial catches, with standard deviations.
5. Rate of growth: Data from marking experiments and quantitative experimental hauls.
6. Rate of mortality: Data from marking experiments and quantitative experimental hauls.
7. Intensity of fishing: Data as to the fisheries considered in 3, 4, and 8.
8. Quantities landed:—
   (a) Total catch (weight) of special fisheries.
   (b) Percentage of large, medium, and small.
   (c) Total number of the various species.
   (d) Size- and age-composition of commercial catches or landings.

C. Shellfish

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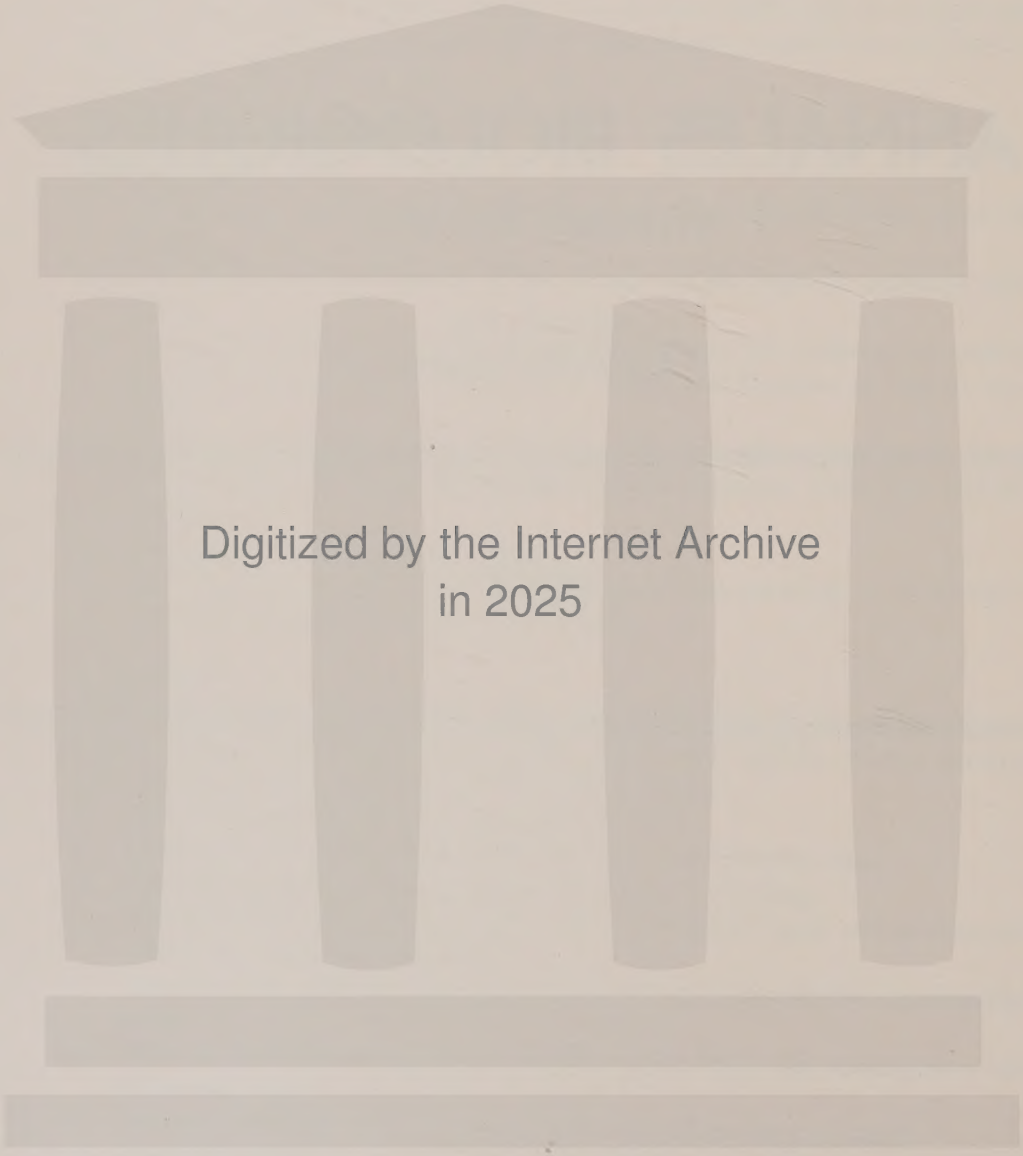
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PREFACE

The comprehensive **hydrographical surveys,** which form parts of the sections dealing with the Distant Northern Seas, the Near Northern Seas, and the Baltic-Belt Seas, are summarized in the introductions to these sections. In the whole Distant Northern Seas area there was a definite tendency towards higher temperatures except for the extreme north and south. In the whole region from the Faroes to West Greenland the Atlantic water layer was thicker than usually and the inflow of Atlantic water to the area west and north of Iceland, through the north-going branch of the Irminger Current, was very pronounced. This was also indicated by the appearance of *Salpa fusiformis* which has never before been recorded from the waters round Iceland. The hydrographical conditions in the Near Northern Seas are summarized in detail in the introduction to that section. The most remarkable feature was that the bottom temperatures in the North Sea were generally higher than in the preceding year. As concerns the Baltic the surface salinity was about normal in the north and relatively high in the south. There is, unfortunately, no information on the hydrographical conditions in the Atlantic area.

The information on **cod** is not so comprehensive and detailed as for the year 1956, except for Greenland. On the offshore banks off West Greenland the 1949, 1950, and 1953 year-classes were predominant in the Icelandic catches, those from 1947 and 1950, however, in the German catches. The 1953 year-class seems to be very rich and much better than anticipated. At South Greenland the 1950 year-class was the richest, and off East Greenland the broods of 1945, 1947, 1949, and 1950 predominated. In the spawning population at Iceland the 1945 and 1949 year-classes were almost equally strong and constituted nearly 60% of the whole stock. In the Barents Sea a considerable decline in the catches was noted, as compared with 1956, owing to decrease in the older year-classes (1948–50) and insufficient recruitment of younger fish (1951–55). The 1957 brood seems, however, to be promising. The Scottish records from the Faroes show an upward trend in the yield per 100 fishing hours from 124.8 cwt. in 1952, through 174.1 in 1956 to 182.2 in 1957. There is no information on cod from the North Sea.

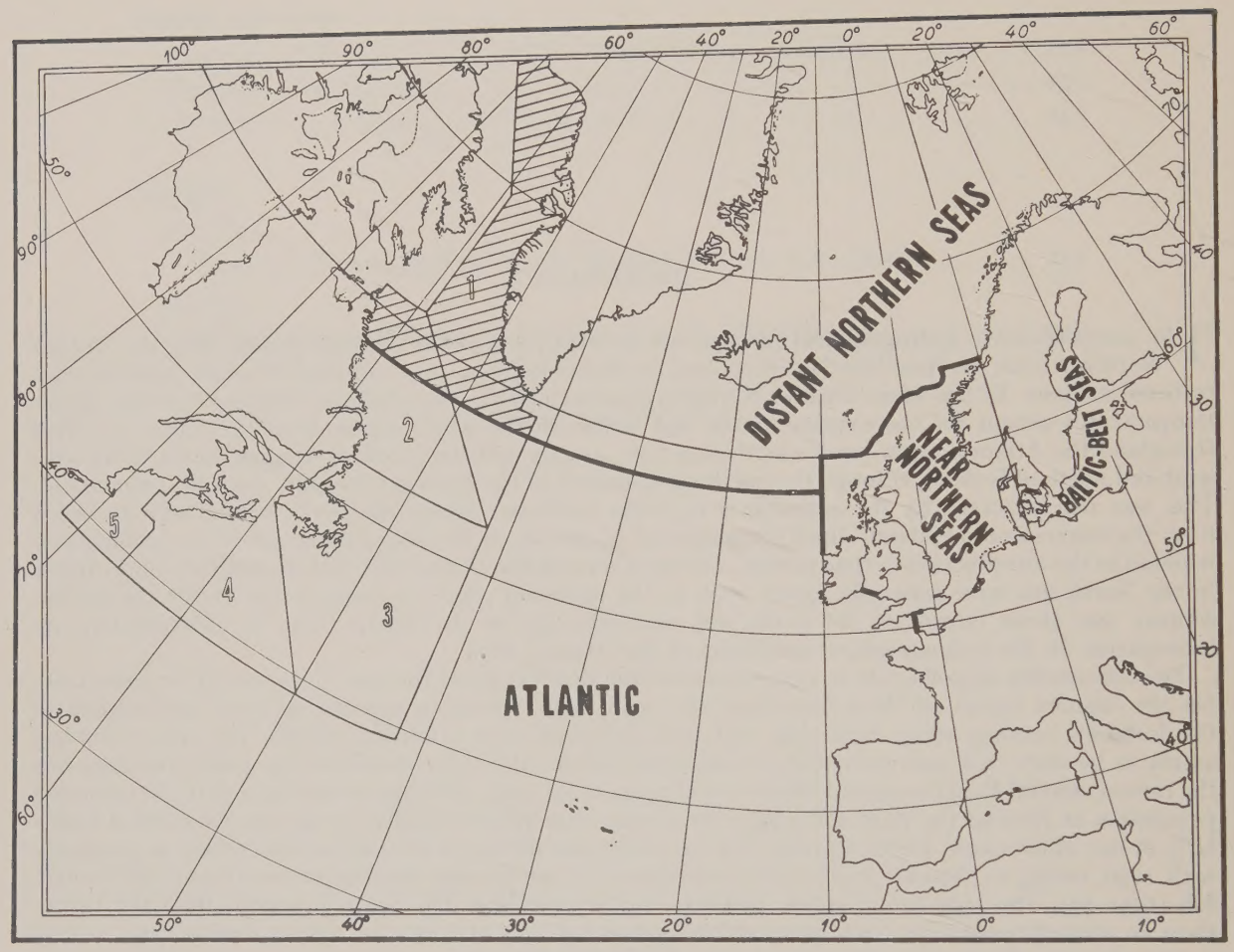
As to the **haddock** we have information from the Barents Sea, the Faroes, and the North Sea. There was a considerable decline in the yields from the Barents Sea owing to the absence of catchable fish all over this area, but the broods from 1956 and 1957 seem to be promising. The 1955 brood was unusually rich in the North Sea. Next in importance was the 1954 brood, but the youngest year-classes from 1956 and 1957 seem to be poor.

The extremely comprehensive German age analyses of **saithe** comprise more than 34,000 fish from Iceland and Norway. At Iceland there was a predominance of the 1949–1951 year-classes, whereas older groups were insignificant. The relatively weak, younger year-classes give evidence of a decline in the size of stock to take place in the near future. The spawning stock at Svinøy was mainly composed of the 1950, 1951, and 1952 broods (75%) and in the Lofoten area the 1952 brood was by far the most numerous (48%).

Attention should be drawn to the Dutch vertebral counts of the North Sea **whiting** (p. 82). The preliminary results seem to indicate that there are at least two stocks of whiting in this area. The English yields per unit of effort by steam trawler were nearly 25% lower than in 1956, and the German stock analyses revealed that in most parts of the North Sea the 1955 brood predominated.

A decline in the **plaice** yields in the German Bight was noticed, but the 1956 brood seems to be rich. In the Danish landings 3 to 5 year-old fish dominated in the catches from the North Sea, but in Skagerak and Kattegat 2 and 3 year-old fish were most abundant.

Records on **halibut** are available from Scotland from the cruises of F.R.V. "Explorer". A decline in numbers was noticed in the Faroe area due to the decrease of the good 1954 year-class, and at Iceland big catches were only taken in the Faxa Bay.



Map showing the areas covered by the Area Committees of the I.C.E.S., and the area of Panel 1 of I.C.N.A.F. (hatched) which is also within the boundary of the Distant Northern Seas Committee.

There are several records on **redfish** at Iceland and Greenland, mainly concerning the length distribution, and there is an important contribution dealing with the sex ratio of redfish from East Greenland and Icelandic waters.

The section on the **herring**, which comprises nearly 50 pages of this volume, contains much detailed and important information. Some of the main features can be summarized as follows:— In the North Sea catches were good in the northern part but remained poor in the south. The Icelandic north-coast catches remained also poor. The yields of the Norwegian winter-herring fishery showed a reduction of about 31% as compared with 1956, and the influx took place farther north than earlier. The Polish catches per day's fishing in Gdansk Bay amounted to 85 kg. only, as against 478 kg. in 1956, the corresponding figures for Bornholm Basin being 688 (1957) and 786 (1956).

I should like to extend my best thanks to the chairmen and contributors, but I am especially indebted to Mrs. H. HARDER of the Central Office, and her assistant, Mrs. M. LARVIG, for their unremitting work in the preparation of this volume.

ÁRNI FRIÐRIKSSON

Distant Northern Seas

INTRODUCTION

Contributions to this report have been received from:—

Denmark:
K. P. Andersen
F. Hermann
J. Smed
P. M. Hansen

England:
H. W. Hill

Germany:
C.-H. Brandes
G. Dietrich
A. Kotthaus

Iceland:
I. Hallgrímsson
J. Magnússon
U. Stefánsson

Scotland:
R. B. Burns
J. H. Fraser
J. M. Lamont
A. D. McIntyre
B. B. Rae

Environment

In 1957 the ice conditions were favourable off West Greenland. The temperature in 50 m. depth was normal. The Arctic part of the West Greenland Current was weak and the warm Atlantic Current was well developed. The mass of warm Atlantic water between the Faroes and West Greenland was thick and has been increasing since 1951. The north-going Irminger Current had a greater extension than in most of the previous years, but the south-going branch of it was normal.

The ice border was nearer to the north-west coast of Iceland in June than in recent years. The influx of warm Atlantic water was greater than in 1956, the temperature in 50 metres off the north coast was about 1°C. higher in June than normally. The temperatures in the tongue of cold water between north-east Iceland and Jan Mayen were as in 1956 higher than normally observed.

Detailed investigations on the Reykjanes Ridge show that the hydrographic conditions there are more irregular than would have been interpreted by a less spread net of observations.

In Icelandic waters detailed survey was made of the phosphate and oxygen distribution.

The hydrographic conditions in the area north of the Faroes were similar to that of previous years. The East Icelandic Current appeared to be somewhat warmer than normal, but its border was situated more southerly. This is in agreement with the Faroe-Shetland Section, which indicated a rather weak inflow of Atlantic water.

During most of the year the bottom temperature and salinity in the Bear Island region were similar to those of the previous year, whereas on the Hope Island Bank the penetration of cold water was considerably stronger. The surface temperatures were higher than normal in the Bear Island region due to high winter transport of Atlantic water, but for the rest of the year the conditions appeared to be normal.

The study of monthly anomalies of the surface temperatures in this area showed that positive anomalies were still dominating. The yearly anomalies were highest around Iceland and east of South Greenland. There was a conspicuous tendency towards higher temperatures in all the area, except its eastern and southern limits.

A very remarkable feature in Icelandic waters was the great influx of *Salpa fusiformis* which in September had overflowed all the shelf west of the island. It had by that time also reached the north coast, but the greatest number was found off the west coast. It was absent from the Faroe-Shetland area.

The Fish

The main species dealt with in this report is the redfish from Iceland and East Greenland. The length distribution of redfish is given for various localities around Iceland. Off the south-east coast of Iceland the length distribution of the small fish showed a peak at 9 cm. in autumn 1956 and spring 1957, but in summer this peak had moved to 11 cm. in the same area. Perhaps this represents the growth of one single year-class.

There is also a discussion of the sex ratio of redfish in East Greenland and Icelandic waters. This ratio differs with depth and locality, but there is no definite conclusion how the sex compositon may change according to the different seasons. Large quantities of small and very small redfish caught by trawl on the East Greenland shelf indicate that these areas are important nursery grounds for redfish. Some of the East Greenland localities investigated had never been fished before.

There are also some data on the halibut from the Faroe Islands and Iceland. The bulk of the catches from the Faroes in 1957 consisted of the 1+ and 2+ groups. Recruitment seems to be on a similar level as in 1955 and 1956. The 1954 year-class is good.

Halibut catches were rather poor in most localities around Iceland except in Faxa Bay. A spawning ground survey was made in the Denmark Strait and it seems that the spawning takes place well off the shelf in the deep waters to the south-west of the commercial fishing grounds.

Finally there is a list of rare fishes from the Distant Northern Seas Area collected during the year.

Jón Jónsson

ENVIRONMENT

Hydrography

Monthly Anomalies of the Surface Temperature of the Sea West of South Greenland 1876—1956

(Figures 1–2; Table 1)

In earlier issues of the *Annales Biologiques* (Vols. 2, 3, 7—13) tables and graphs showing the variation of the sea surface temperature in, i.a., an area A: 55°—70°N., 50°—58°W., during the period 1876—1956 have been given.

In a series of years, however, the number of observations located south of 60°N. in area A has been exceedingly small, and in 1957 there were no observations at all from that part of the area A in the material used. Under these circumstances it seems preferable in future surveys of the fluctuations of temperature to replace the area A by area A_1 (60°—70°N., 50°—58°W., see Fig. 1).

In order to have comparable values also for the past years mean monthly anomalies over area A_1 have been computed for the period 1876—1956. The values found are given in Table 1; for the months December, January, and February no observations are available. For each year the existing monthly means are averaged in the last column of Table 1, and these averages are plotted in Figure 2.

Finally it should be mentioned that replacement of area A by area A_1 would be preferable also from the point of view that the fluctuations of temperature may sometimes be rather different in the northern and southern parts of the large area A. This is so much more likely since, as it has been pointed out to me by Prof. J. Bjerknes, the meteorological conditions are fairly different in these parts of area A, western winds predominating in the south, more changing winds in the north.

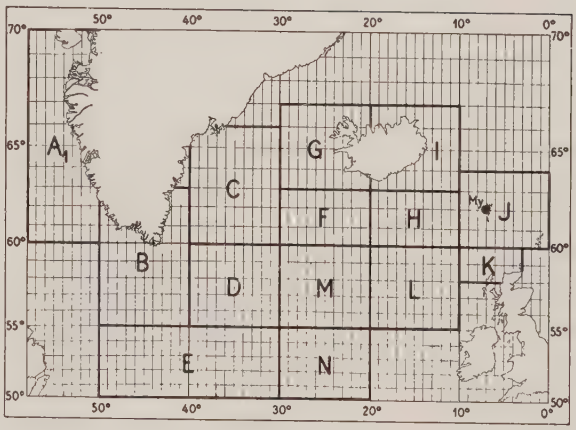


Figure 1. Location of areas A_1 to N and of Station My.

Jens Smed

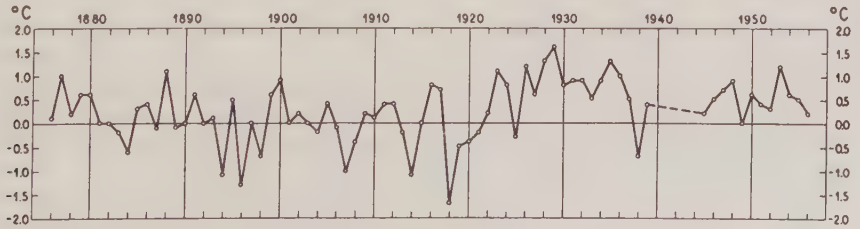


Figure 2. Yearly anomalies of surface temperature in the area A_1 (see Figure 1), 1876—1956.

Table 1. Monthly anomalies (△ °C.) and numbers (n) of observations of the surface temperature in the area A_1 (60°N.—70°N., 50°W. –58°W.) during the years 1876—1956

	March		April		May		June		July		August		September		October		November		Average of
	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△-values
1876	—	—	0.9	10	0.2	14	0.6	6	0.0	11	–0.7	20	–0.2	10	0.2	5	—	—	0.1
1877	—	—	1.2	28	1.5	33	1.1	49	0.9	44	1.3	48	0.2	19	—	—	—	—	1.0
1878	—	—	0.0	30	0.5	27	0.2	59	0.4	56	0.6	54	–0.6	38	0.0	4	—	—	0.2
1879	—	—	1.6	17	0.7	11	0.7	94	0.6	62	0.7	79	–1.0	7	—	—	—	—	0.6
1880	—	—	0.4	18	0.4	19	1.5	47	0.8	77	0.5	77	–0.3	19	0.9	1	—	—	0.6
1881	—	—	1.0	14	0.1	25	–0.2	76	–0.4	73	–0.7	97	–0.5	28	0.6	1	—	—	0.0
1882	—	—	–0.2	21	0.4	27	0.2	54	0.4	70	–0.4	79	–0.5	31	—	—	—	—	0.0
1883	—	—	—	—	–0.1	43	–0.6	57	–1.0	38	–0.5	85	0.6	7	0.6	3	—	—	–0.2
1884	—	—	–0.8	19	–0.1	48	–0.5	22	–0.1	68	–0.7	60	–1.2	29	–0.5	28	—	—	–0.6
1885	—	—	0.7	15	0.6	19	–0.6	62	0.2	35	0.5	62	0.2	29	—	—	—	—	0.3
1886	—	—	1.0	2	0.3	37	0.3	94	0.1	39	0.6	84	0.2	23	0.5	21	—	—	0.4
1887	—	—	0.1	30	–0.3	24	–0.5	43	–0.1	84	–0.8	61	–0.6	18	1.8	2	—	—	–0.1
1888	—	—	—	—	2.0	10	1.3	69	0.7	66	1.2	45	0.5	6	1.0	11	—	—	1.1
1889	—	—	0.2	11	0.4	14	–0.2	46	–0.6	87	–0.7	57	0.1	26	—	—	—	—	–0.1
1890	—	—	0.1	10	0.3	18	0.1	64	0.0	66	–0.6	56	0.1	14	—	—	—	—	0.0
1891	—	—	2.2	3	0.1	9	0.3	105	–0.1	62	0.3	93	—	—	—	—	—	—	0.6
1892	—	—	–0.1	23	0.5	27	0.4	99	–0.5	75	0.1	67	–0.3	38	—	—	—	—	0.0
1893	—	—	0.5	1	–0.5	35	–0.5	75	–0.5	70	0.6	77	1.1	58	—	—	—	—	0.1
1894	—	—	–2.0	4	–0.5	54	–1.2	128	–0.8	35	–1.6	57	–0.8	55	–0.6	4	—	—	–1.1
1895	—	—	0.0	23	0.1	53	0.1	77	0.4	63	0.7	84	1.5	42	—	—	—	—	0.5
1896	—	—	–1.0	10	–3.0	30	–0.2	83	–0.7	35	–1.2	114	–0.4	71	–2.4	1	—	—	–1.3
1897	—	—	–1.2	2	–0.1	18	0.5	81	0.0	75	0.2	78	0.5	51	–0.1	12	—	—	0.0
1898	—	—	–0.4	6	–0.6	53	–0.4	143	–0.5	17	–1.0	67	–1.3	51	–0.4	8	—	—	–0.7
1899	—	—	1.7	27	0.7	56	0.2	66	0.6	12	0.4	89	–0.1	44	0.4	9	—	—	0.6
1900	—	—	–0.1	14	0.6	34	0.6	112	1.3	38	0.9	73	1.9	2	—	—	—	—	0.9
1901	—	—	0.9	3	–0.2	37	–0.2	87	–0.2	46	–0.4	90	0.0	30	—	—	—	—	0.0
1902	—	—	0.0	31	0.2	36	0.4	87	–0.2	53	0.2	56	0.7	17	—	—	—	—	0.2
1903	—	—	–0.4	30	–0.9	42	0.1	51	0.3	37	0.1	71	1.0	33	—	—	—	—	0.0
1904	—	—	–1.0	4	–0.7	62	–0.1	59	–0.5	29	0.5	70	0.8	17	—	—	—	—	–0.2
1905	—	—	1.0	3	0.6	40	0.6	41	–0.2	57	0.1	55	0.1	16	—	—	—	—	0.4
1906	—	—	–0.7	12	0.4	61	–0.8	32	–0.9	18	0.1	79	0.3	53	0.7	4	—	—	–0.1
1907	—	—	–1.7	42	–0.9	51	–1.1	66	–0.6	36	–0.7	70	–0.6	34	–1.3	9	—	—	–1.0
1908	—	—	0.8	27	–0.7	51	–1.1	58	–0.5	44	–0.6	82	0.1	57	–0.9	11	—	—	–0.4
1909	—	—	–0.1	22	0.2	74	0.3	57	0.6	18	0.5	72	0.7	28	–0.6	6	—	—	0.2
1910	—	—	–0.7	35	–0.1	32	–0.7	29	0.2	71	1.5	85	0.7	36	–0.5	18	—	—	0.1
1911	0.0	2	–0.1	43	–0.4	30	–0.3	9	1.1	39	1.4	54	0.6	25	0.9	9	—	—	0.4
1912	—	—	0.6	63	0.2	64	0.5	54	0.0	124	0.1	114	0.6	52	—	—	0.5	8	0.4
1913	—	—	–0.6	24	0.1	131	0.0	89	–0.1	43	–0.5	80	–0.4	218	0.1	64	–0.2	5	–0.2
1914	—	—	–0.7	121	–0.9	144	–2.0	18	–1.1	155	–1.4	174	–0.7	117	–0.6	16	—	—	–1.1
1915	—	—	0.2	8	0.7	20	0.1	114	0.4	65	–0.1	103	0.0	71	–0.2	19	–0.7	3	0.0

Monthly Anomalies of the Surface Temperature in Areas of the Northern North Atlantic in 1957

(Figures 1, 3–4; Tables 2–3)

On the basis of data collected in 1957 by the Danish Meteorological Institute from Danish and Icelandic ships in the northern North Atlantic, anomalies of surface temperatures have been evaluated for each month and each 1°-square, using RYDER's grand monthly means for the period 1876—1915 as standards. These anomalies were then averaged over the areas indicated in Figure 1.

The results are given in Table 2, where the monthly anomalies are recorded, together with the numbers of observations on which they are based. In the last column of the table the monthly anomalies for each area have been averaged for the year.

Table 2 shows that positive anomalies are still highly predominating. In fact, none of the yearly anomalies given in the last column of Table 2 is negative. The distribution of the yearly anomalies over the region is shown in Figure 3. Evidently the anomalies are highest around Iceland and east of South Greenland.

The average of the yearly anomalies given in the last column of Table 2 is 0.7°C. This is 0.2°C. higher than in 1956. Fig. 4 shows the geographical distribution of the variation of temperature from

Table 1 (continued)

	March		April		May		June		July		August		September		October		November		Average of
	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△-values
1916	—	—	0.5	60	1.3	86	0.2	12	0.8	32	0.6	114	0.7	166	1.3	32	—	—	0.8
1917	—	—	—	—	0.4	30	0.4	168	1.3	139	1.4	172	1.3	15	−0.5	21	—	—	0.7
1918	—	—	−1.8	26	−1.6	71	−2.1	160	−2.4	131	−1.0	140	−0.3	139	—	—	−2.4	7	−1.7
1919	—	—	−1.6	11	0.2	75	−1.7	246	0.3	44	−0.5	125	−0.5	37	−0.4	94	0.0	19	−0.5
1920	—	—	—	—	0.4	98	1.2	1	−0.2	236	−1.4	204	−1.0	136	−1.2	25	—	—	−0.4
1921	—	—	−0.8	18	0.1	161	0.0	75	0.7	108	−0.3	112	−0.5	162	0.1	36	−0.5	18	−0.2
1922	—	—	0.7	22	0.4	90	0.3	12	0.0	185	0.0	277	−0.2	77	0.4	35	—	—	0.2
1923	—	—	0.9	99	1.2	82	1.9	86	1.0	139	1.1	248	1.5	138	1.1	23	0.4	6	1.1
1924	—	—	0.7	52	1.2	49	1.4	173	0.7	103	1.2	262	1.7	92	−0.1	15	−0.3	16	0.8
1925	—	—	−0.6	7	−0.3	130	−0.4	246	−0.1	271	0.0	230	0.6	109	−0.6	10	−1.0	7	−0.3
1926	—	—	0.6	45	1.8	90	1.4	215	0.9	97	1.3	305	1.6	138	1.5	70	0.7	7	1.2
1927	—	—	1.2	15	−0.2	2	1.3	158	0.0	226	1.7	229	2.0	44	—	—	−1.8	12	0.6
1928	−1.8	2	1.0	29	1.9	101	2.0	138	1.0	167	1.9	108	1.8	128	2.9	79	0.6	4	1.3
1929	—	—	2.1	94	2.0	46	1.1	167	2.0	127	1.8	229	2.0	57	1.4	43	0.0	6	1.6
1930	—	—	1.1	69	1.2	48	0.9	92	0.3	112	1.1	179	2.0	62	0.2	23	−0.4	24	0.8
1931	—	—	0.0	45	0.8	90	0.7	125	1.0	166	1.8	54	2.0	80	1.5	33	−0.3	7	0.9
1932	—	—	1.0	46	1.0	29	1.0	104	1.5	65	1.0	65	1.2	84	1.2	24	−0.4	10	0.9
1933	−0.6	4	−0.3	46	0.4	41	0.1	104	1.0	173	1.5	82	1.1	15	0.7	34	0.9	7	0.5
1934	—	—	0.0	54	0.7	59	0.6	121	1.2	104	1.5	67	1.7	47	0.5	41	0.7	9	0.9
1935	—	—	0.4	59	0.9	16	1.2	116	1.0	63	1.6	60	3.0	18	1.3	28	1.1	9	1.3
1936	—	—	1.1	66	1.0	48	0.6	88	1.1	82	1.4	27	1.4	57	0.6	63	0.6	7	1.0
1937	−2.2	2	−0.3	39	1.0	108	0.4	77	1.3	108	0.9	114	1.8	40	0.5	85	0.9	5	0.5
1938	—	—	−0.6	31	−0.2	114	−0.6	90	−0.9	101	−0.9	26	−0.1	63	−0.8	17	−1.4	13	−0.7
1939	—	—	0.1	86	0.1	106	0.2	33	0.1	42	0.3	61	0.9	58	1.2	24	—	—	0.4
1940	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1941	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1942	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1943	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1944	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1945	—	—	—	—	—	—	—	—	0.0	34	0.8	40	−0.6	72	0.4	64	—	—	0.2
1946	—	—	0.2	7	1.1	48	0.7	37	0.0	87	0.0	18	0.4	73	1.4	15	0.2	18	0.5
1947	—	—	0.3	13	2.3	53	0.5	20	1.6	9	0.9	46	0.5	10	0.6	40	−0.9	21	0.7
1948	—	—	0.1	35	0.3	53	1.2	120	1.5	27	1.4	123	2.0	78	1.0	41	0.0	11	0.9
1949	2.0	1	−0.8	33	−0.4	51	0.0	84	−0.4	113	0.0	41	0.3	37	−0.3	29	−0.8	24	0.0
1950	—	—	0.5	3	0.8	42	0.8	46	0.2	118	0.6	119	1.1	51	0.5	45	−0.1	18	0.6
1951	−1.6	2	0.2	13	0.6	73	0.7	111	0.3	185	0.4	57	1.4	86	0.8	57	0.4	16	0.4
1952	—	—	0.1	15	0.6	56	0.5	123	−0.1	264	0.5	70	1.2	42	−0.3	46	−0.4	9	0.3
1953	—	—	2.2	10	1.6	49	1.0	68	1.2	167	0.7	122	1.4	97	0.7	63	0.5	10	1.2
1954	—	—	−0.3	18	0.8	106	0.9	173	0.3	244	1.3	210	1.0	129	0.7	92	−0.3	9	0.6
1955	0.8	9	1.2	16	1.2	107	1.2	188	−0.5	210	−0.3	97	0.3	78	0.7	55	0.2	12	0.5
1956	−1.8	3	0.5	14	0.3	88	0.0	140	0.7	149	1.0	46	0.6	139	0.6	106	−0.2	6	0.2

Table 2. Monthly anomalies (△ °C.) and numbers (n) of observations of the surface temperature in the areas A_1–N (see Figure 1) during 1957

	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Aver.
	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	of △-val.
A_1	—	—	—	—	−1.5	2	0.6	30	0.3	103	0.7	67	0.9	136	1.5	59	1.5	46	0.8	51	0.1	9	—	—	0.5
B	—	—	—	—	0.5	9	0.6	89	0.7	57	0.6	52	0.9	83	1.0	72	0.6	40	−0.4	87	0.1	54	2.0	7	0.7
C	—	—	—	—	0.9	12	0.4	36	0.9	36	0.8	37	1.6	44	2.0	43	1.0	26	0.9	34	0.3	6	1.3	3	1.0
D	1.5	10	0.5	1	0.1	26	0.4	82	0.6	63	1.2	35	1.1	12	1.5	30	0.8	28	0.7	45	−0.4	57	0.3	8	0.7
E	−0.2	55	−0.5	53	0.2	47	−0.5	62	−0.4	76	−0.2	73	0.0	56	0.7	66	0.9	62	0.3	62	−0.3	107	0.6	23	0.0
F	−0.6	5	1.5	3	0.6	19	0.3	91	0.9	83	1.0	44	1.1	46	1.6	39	−0.1	36	0.5	27	0.3	25	0.4	6	0.6
G	1.0	8	1.5	7	1.3	15	1.2	11	1.0	18	1.1	8	0.9	3	1.4	18	1.1	17	0.9	23	0.6	12	0.8	29	1.1
H	1.2	42	1.0	47	0.9	52	0.6	131	1.0	85	0.8	78	0.6	57	0.6	71	0.5	67	0.2	51	0.6	58	1.1	44	0.8
I	1.4	12	1.5	9	0.9	13	1.6	4	1.0	13	1.5	27	1.6	3	1.3	16	1.3	23	1.0	7	1.5	12	1.6	10	1.4
J	0.8	55	1.0	52	0.9	51	0.8	75	0.7	72	0.1	93	0.1	46	0.1	66	0.2	48	0.5	31	0.2	50	0.7	30	0.5
K	1.2	19	0.5	42	0.8	45	0.7	71	0.8	50	0.4	72	0.2	52	0.0	70	−0.2	55	0.0	47	0.3	59	1.0	46	0.5
L	−0.3	18	0.6	43	1.1	62	1.0	62	0.7	45	0.9	85	1.0	59	0.9	45	0.3	50	0.5	61	0.6	66	1.0	47	0.7
M	−0.3	18	0.6	33	0.9	40	0.7	39	0.8	49	1.0	47	0.8	43	1.4	40	0.8	60	0.6	67	0.4	79	0.8	43	0.7
N	—	—	−0.2	12	0.4	27	−0.1	38	0.4	31	1.2	37	0.2	27	1.8	16	—	—	—	—	—	—	0.6	8	0.5

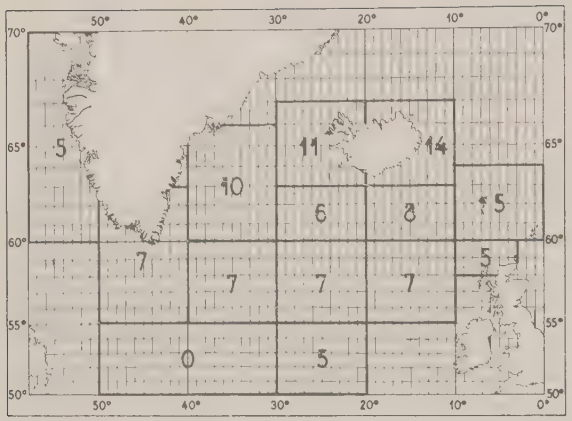


Figure 3. Yearly anomalies of surface temperature (°C.) for 1957.

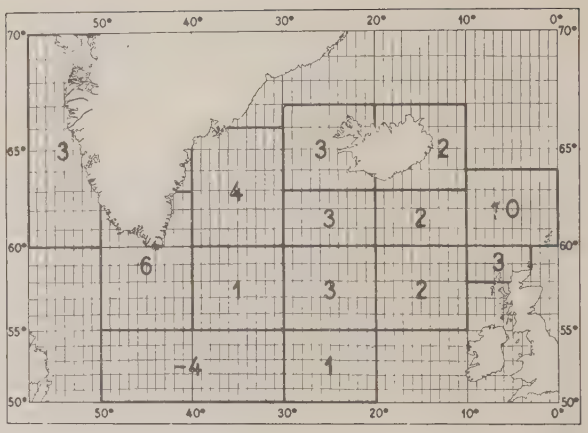


Figure 4. Variation of surface temperature (°C.) from 1956 to 1957.

Table 3.

Grand monthly means of the surface temperatures (°C.) at Myggenæs, Faroes (My in Figure 1) during the period 1914—50 and deviations for 1957 from these means

	Jan.	Feb.	March	April	May	June
Means 1914–50	6.3	6.0	5.9	6.3	7.1	8.2
Deviations 1957	0.4	–0.2	0.1	0.4	0.3	0.3

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Means 1914–50	9.3	9.8	9.7	9.1	7.9	7.0	7.7
Deviations 1957	0.1	0.0	–0.1	–0.1	0.1	–0.1	0.1

1956 to 1957. It appears that there is a conspicuous tendency towards higher temperatures over the whole region, excepting its eastern and southern limits.

Table 3 gives the grand monthly means of the surface temperature at Myggenæs, Faroes (Station My in Figure 1) for the period 1914—1950, together with deviations of the 1957 values from these means.

I am greatly indebted to Messrs. I. Sestoft and H. Thomsen of the Danish Meteorological Institute for placing the data at my disposal.

Jens Smed

Hydrographic Conditions in the Barents Sea in 1957

(Figures 5–8; Table 4)

On each of the six cruises, which the research vessel "Ernest Holt" made to the Barents Sea during 1957, bottom temperature and salinity observations were taken, and on all but the first cruise a thermograph was run continuously at a depth of 4.5 m. Bottom temperature, bottom salinity, and surface temperature charts have been drawn for each cruise including the first, when surface temperature observations were made in the Bear Island area with a Nansen reversing water bottle. These are to be published shortly, together with all the hydrographic data from these cruises, in a MAFF publication. During each of the three cruises in May, August/September, and November/December, the Malangen, Fugløy—Bear Island, East Bear Island, and West Bear Island hydrographic sections were completed. In addition, in May and September the North Cape section was worked and in December the Vardø—Eastern Basin section was made. A diagram showing the positions of these sections was given by Hill (1957). Two further sections were worked across the West Spitsbergen Current in May in latitudes 73°02′N. and 79°07′N. respectively.

Bottom temperature and salinity

The bottom temperature distribution around Bear Island in March is shown in Figure 5. Bottom temperatures near the island were approximately 1°C. higher than in 1955 and 1956 due to the abnormally high influx of Atlantic water in December 1956, but in the Bear Island Channel the advance of warm water was less marked than in

Figure 5. Bottom temperature distribution in the Bear Island region; 8.—20. March 1957.

1955. The bottom salinity distribution is shown in Figure 6. Unfortunately, bad weather during the early part of 1956 prevented the taking of sufficient salinity observations at Bear Island to provide a comparison, but it is clear that conditions in March 1957 were similar to those obtaining the previous December, although in the immediate vicinity of Bear Island the salinity was 0.2‰ higher.

By the beginning of May the Arctic water of the Bear Island Current extended across the bank east of the island. The South-East Gullies were covered with water below 1°C. and 35.0‰ salinity and the 2°C. isotherm was pushed well into the deep part of the Bear Island Channel. During the rest of the year the bottom temperature and salinity distributions at Bear Island were similar to those observed at the same times in previous years, but on the Hope Island Bank there was a striking difference in the degree of penetration of the tongue of cold low-salinity water of the Bear Island Current. In August 1956 in this tongue, temperatures of less than -1°C. reached halfway from Hope Island towards Bear Island, whereas in August 1957 and again in October 1957 the southernmost limit was east of Hope Island. In the latter month Atlantic water in the Bear Island Channel was seen to be flowing over cold bottom water in the Hope Island Deep and impinging on the edges of the Hope Island and Great Banks at the northern end of the channel.

In December a temperature gradient was found similar to that which has prevailed at other times when the "Ernest Holt" has been working between Skolpen Bank and Goose Bank, but the band of warm water, which normally lies along the edge of Goose Bank and which has been studied in connexion with cod concentrations, was considerably narrower than in 1956 and more like the conditions of January 1952.

Surface temperature

Surface temperatures on the Bear Island Bank and in the mouth of the Bear Island Channel in March were 1°C. warmer than normal due to the high winter transport of Atlantic water, but the form of the distribution was as found on earlier occasions at that time of year.

Figure 6. Bottom salinity distribution in the Bear Island region; 8.—20. March 1957.

During the rest of the year surface temperatures around Bear Island and on the Hope Island Bank were similar to those described by Hill (Ann. Biol., 13) but on the June/July cruise, the 5°C. isotherm was found to correspond approximately with the 100 fathom isobath along the West Spitsbergen coast, and to the north of Spitsbergen the surface temperature fell rapidly, ice being encountered at 80°21′N., 13°03′E.

In the Bear Island Channel in August the surface waters were about 1°C. warmer than in 1956, but from temperatures plotted for the control station "F", (Lee, Ann. Biol., 12), it is clear that although high during this month, the surface temperature in the channel during the rest of the year was only average. The surface temperature at control station "A" in Norwegian coastal water appeared to be normal for the first part of the year but after October was lower than for any year since 1950, with the exception of 1956.

In the south-eastern Barents Sea in December surface waters above 3°C. reached farther east than in 1956, covering Skolpen Bank and the edge of Goose Bank with a warm tongue 40 miles wide as far as 72°N.

Sections and transports

None of the hydrographic sections worked at Malangen, Bear Island, North Cape, or Vardø at the times stated above differed significantly from the temperature and salinity distributions which might normally be expected. There were, however, two new sections made across the West Spitsbergen Current in May; at Kongsfjord and in the mouth of the Bear Island Channel. These are shown in Figures 7 and 8. The Bear Island Channel section shows the core of the Atlantic Current, warmer than 5°C., over the edge of the continental shelf at the point where it is split by the Bear Island Current into the West Spitsbergen main stream and the branch current which runs along the edge of the bank towards the South-East Gullies. The 35.1‰ isohaline indicates that partition was occurring. Figure 8 shows that the temperature of the current is 2°C. cooler at Kongsfjord and that the core runs

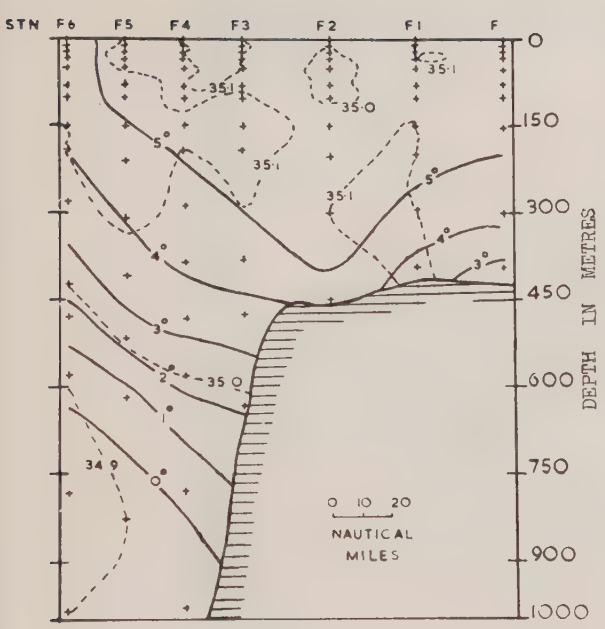


Figure 7. Temperature and salinity distributions on the Bear Island Channel section; 1.—8. May 1957.

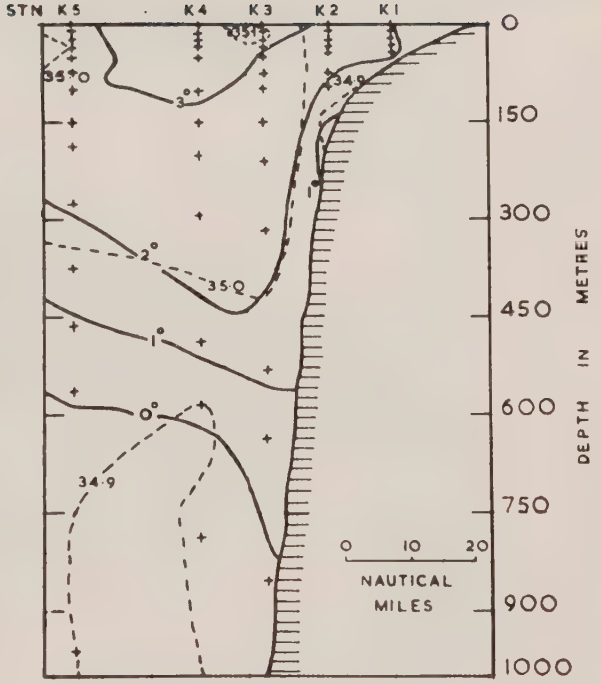


Figure 8. Temperature and salinity distributions on the Kongsfjord section; 14.—15. May 1957.

Table 4. The volume transport above 400 m. on the West Bear Island and Malangen sections in km³/hr.

1957	West Bear Island	Malangen
May	3.61	11.83
August	0.52	8.80
December	4.01	10.51

close to the edge of the bank, as is the normal state on the West Bear Island and Malangen sections. It can also be seen that the large volume of water having a salinity greater than 35.1‰ has been reduced to negligible proportions.

The volume transport above 400 m. (reference level 750 decibars) at Malangen and West Bear Island is given in Table 4. The volume transports above 400 m. on the Bear Island Channel and Kongsfjord sections were calculated as 4.93 km.³/hr. and 1.24 km.³/hr. respectively. This shows that there is a sharp reduction in the volume of north-going water between Malangen and the Bear Island Channel due to the North Cape Current and that there is a more gradual loss later into the various circulatory current systems which are found alongside the West Spitsbergen Current.

H. W. Hill

Hydrographic Conditions in Icelandic Waters in June 1957

(Figures 9-17)

The Icelandic research vessel "Ægir" made a hydro-biological survey in Icelandic waters from 28. May to 23. June. Figures 9—11 show the location of the stations worked and the distribution of temperature and salinity at 20, 50, and 100 metres.

This year, as in 1956, the ice border was found closer to the north-west coast of Iceland than has been observed in the most recent years. Off Cape Horn it was found at a distance of 25—30 naut. miles off the coast, but farther east, off Húnaflói, it had a direction to the north in very much the same way as in 1956.

In the area west and north of Iceland the temperature in the uppermost 20 metres was somewhat higher than in 1956, especially off the north coast. It was lower than in 1954, but similar to what it was in 1955. At 50 metres the temperature was about 1°C. higher north of Iceland than normally observed for June. Also at 100 metres does the year 1957 rate among the warmest years.

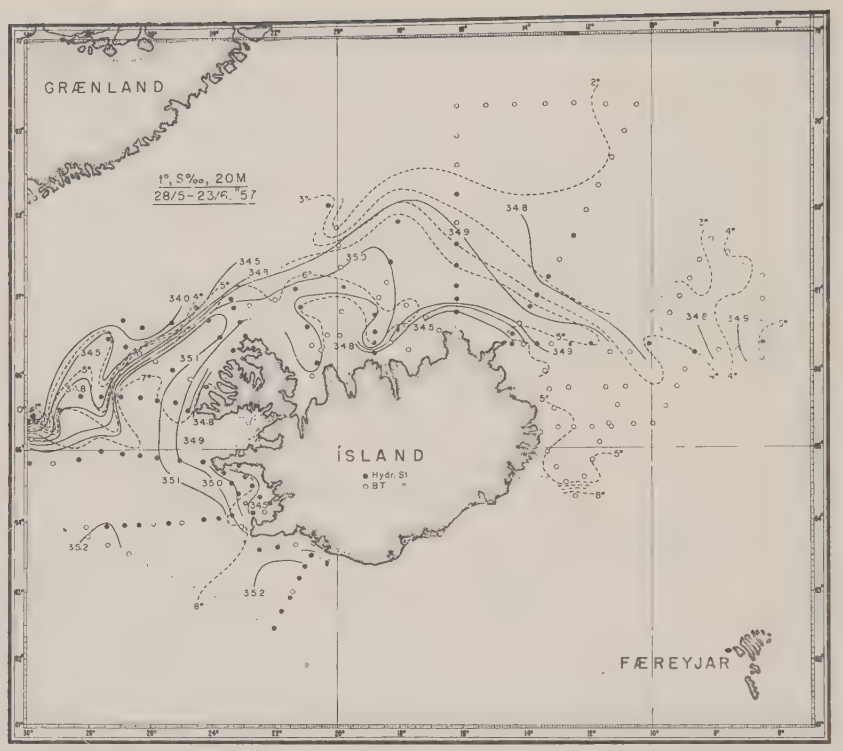


Figure 9. Temperature and salinity, 20 metres, 28. May to 23. June 1957.
The black dots indicate hydrographic stations and the circles BT stations.

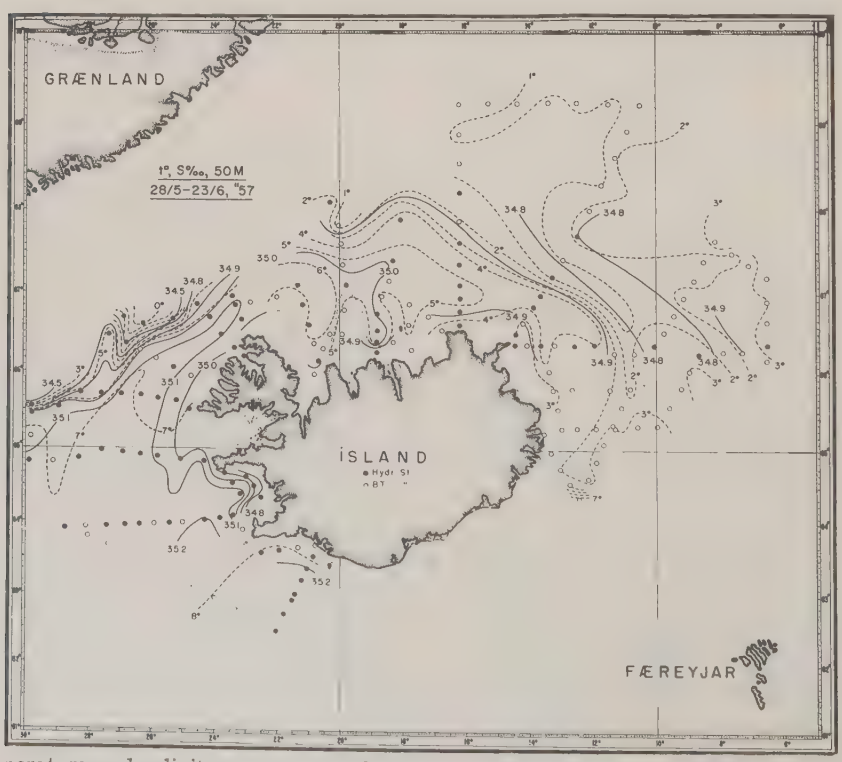


Figure 10. Temperature and salinity, 50 metres, 28. May to 23. June 1957. The symbols are the same as in Figure 9.

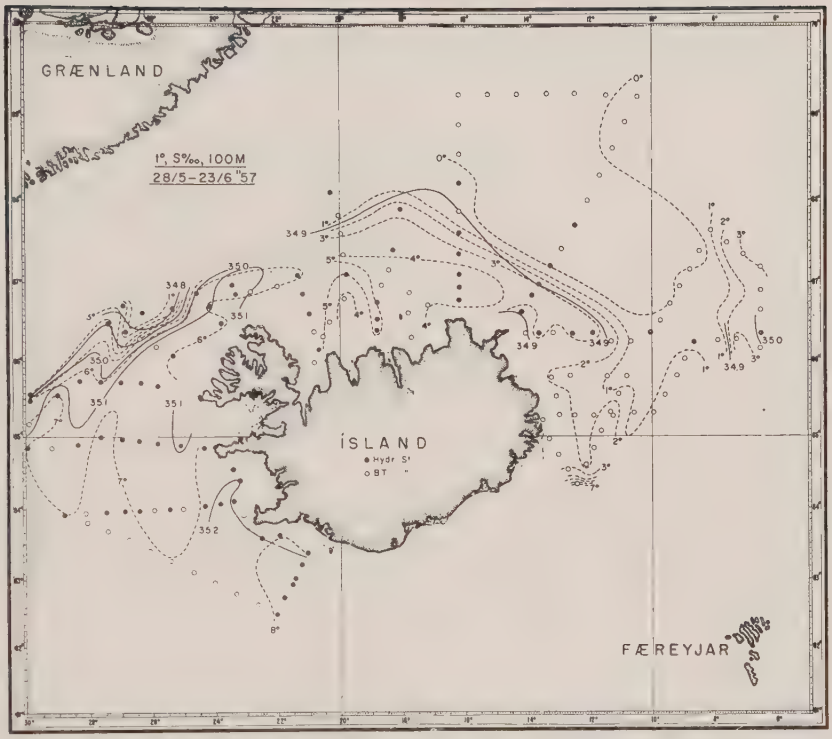


Figure 11. Temperature and salinity, 100 metres, 28. May to 23. June 1957.
The symbols are the same as in Figure 9.

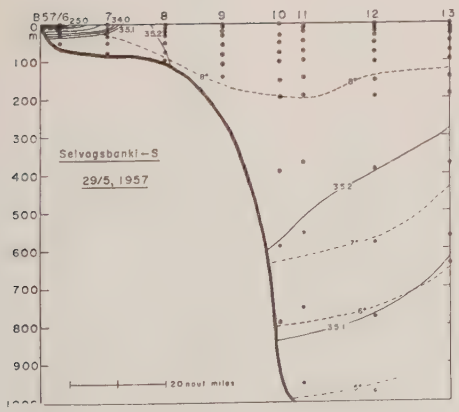


Figure 12. Section across the Selvogsbanki.

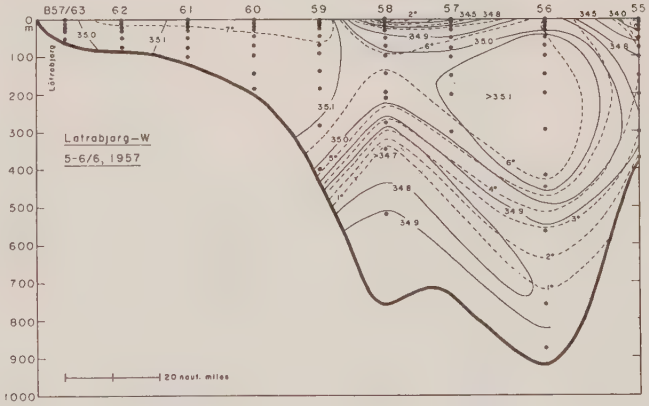


Figure 13. Section west of Látrabjarg.

The temperature in the uppermost 50 m. in the tongue of cold water south of Jan Mayen and east of Iceland was this year as well as in 1956 higher than normally observed. However, at 100 m. the amount of polar water in these regions seemed to be somewhat greater in 1957, and the western branch of the East Icelandic Current was more conspicuous in 1957 than in 1956.

The hydrographic features are further illustrated by the vertical sections shown in Figures 12—15. In the sections off the south-west and west coasts (Figs. 12 and 13) the conditions were similar to those found in 1956. Off the north coast, however, (Figs. 14 and 15) the distribution of Atlantic water was decidedly greater, resembling that observed in June 1954 and 1955.

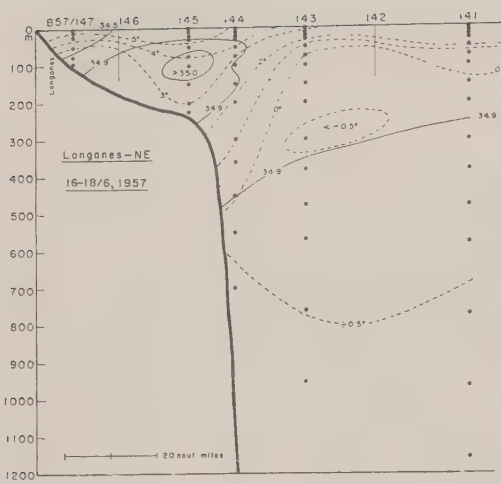


Figure 14. Section north of Siglunes.

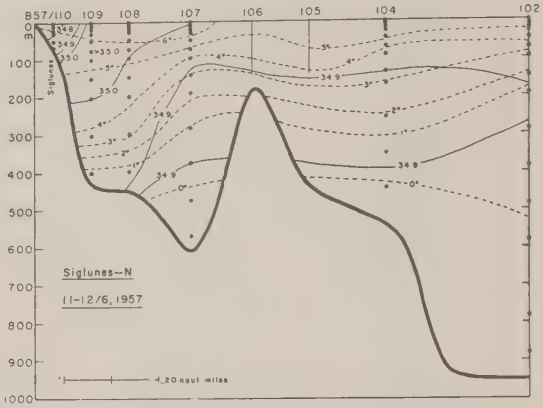


Figure 15. Section north-east of Langanes.

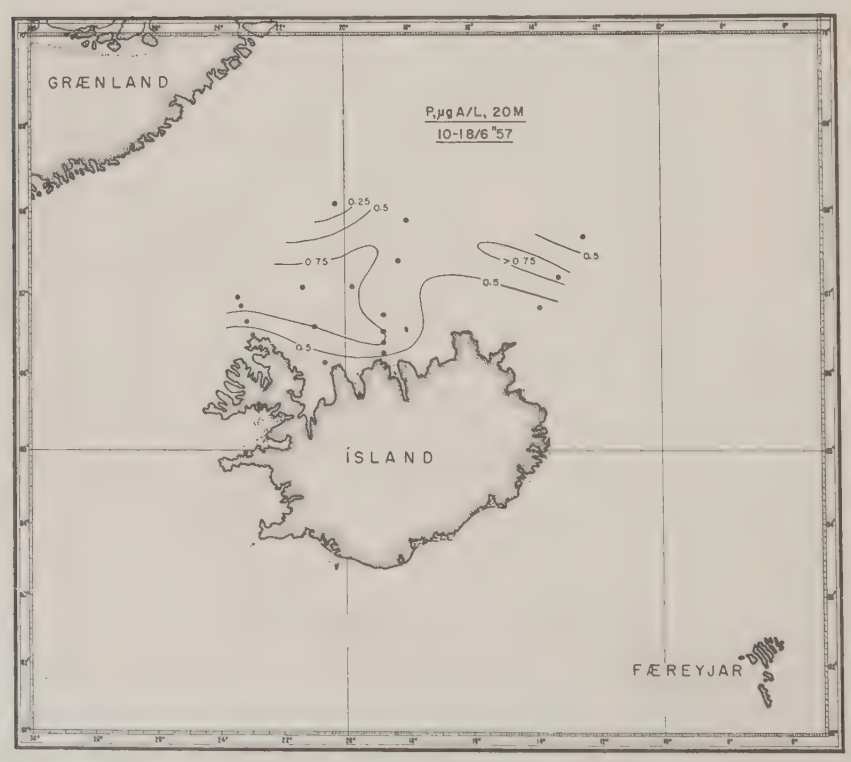


Figure 16. Concentration of inorganic phosphates at 20 metres, µg.-at/l., 10.—18. June 1957.

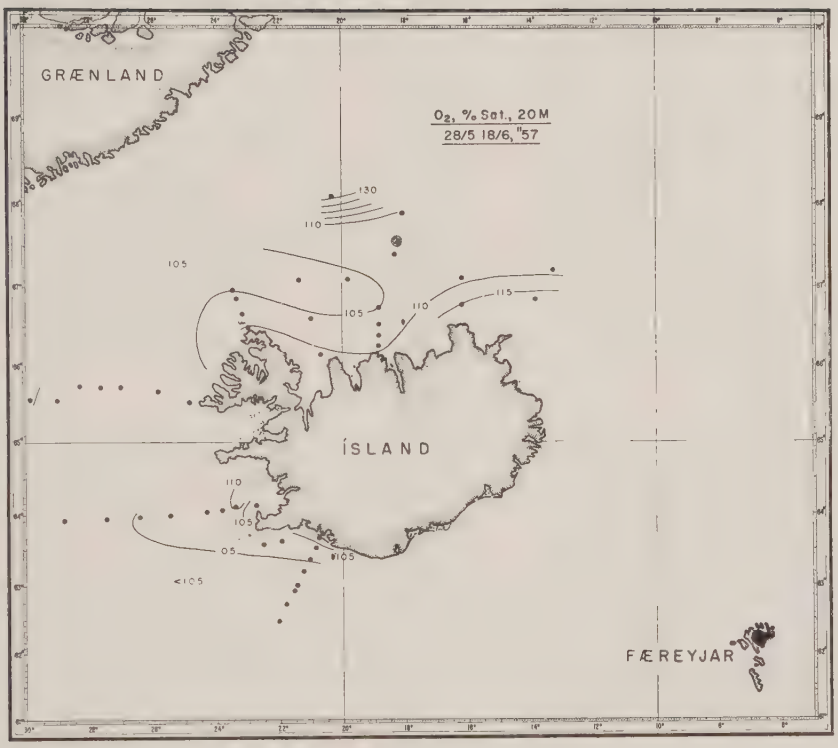


Figure 17. Percentage saturation of dissolved oxygen at 20 metres, 28. May to 18. June 1957.

Figures 16 and 17 depict the concentration of free phosphates and the percentage saturation of dissolved oxygen[1]) at 20 m. depth. The following main features may be distinguished:—

(a) There existed a close negative correlation between the phosphate concentrations and the saturation values of oxygen.

(b) Low phosphate values (and high saturation values) were found near the coast and again off the insular shelf, with waters rich in phosphates (and with low oxygen values) in between. This intermediate region corresponds to the core of the North Icelandic Irminger Current.

(c) Along the north coast of Iceland the phosphate concentration was as usual found to decrease in the direction of flow, being 0.5 to 0.8 units in the western part and 0.3 to 0.6 units in the eastern part of the coastal area. The reverse was true of the oxygen distribution. Thus the variations in the concentration of nutrients and the saturation values of dissolved oxygen appear to be associated with the distribution of Atlantic water.

It is of interest to note that according to verbal information received from mag. scient. Thórunn Thórðardóttir who carried out productivity measurements in the area using the ^{14}C technique, the oxygen saturation values correlated rather closely with the productivity values. In regions with great productivity high saturation values were also found and vice versa.

[1]) The saturation values were calculated by means of Fox' tables.

Unnsteinn Stefánsson

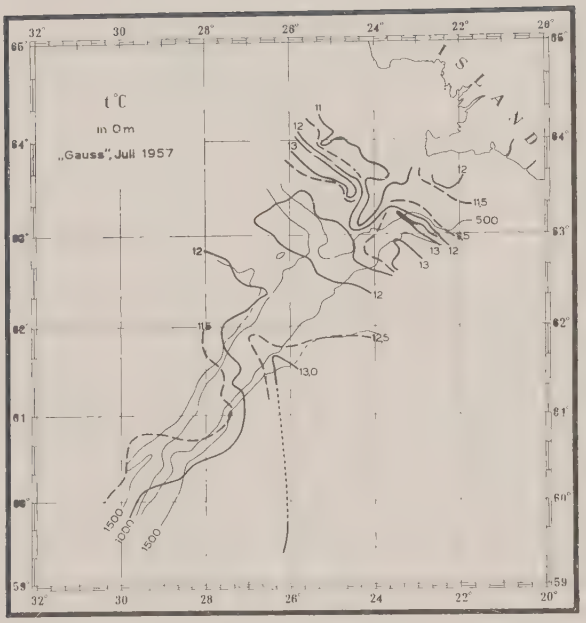


Figure 18. Surface temperature south-west of Iceland in the region of Reykjanes Ridge, observed during the cruise of "Gauss" in July 1957. Depth contours at 500, 1000, and 1,500 metres.

Figure 19. Surface salinity south-west of Iceland in the region of Reykjanes Ridge, observed during the cruise of "Gauss" in July 1957. Depth contours at 500, 1000, and 1,500 metres.

Hydrographic Details of the Waters South-West of Iceland in July 1957

(Figures 18–19)

In continuation of the surveying work in the Irminger Sea by "Gauss" in August 1956 (see DIETRICH, Dtsch. Hydrogr. Zeitschr., **10**: 39—61, 1957) a special survey was undertaken in July 1957 of the region south-west of Reykjanes and Reykjanes Ridge, southwards to 60°N. During this work the distribution of temperature and salinity at the surface was observed. The results are given in Figs. 18 and 19, based on observations at 472 positions worked from 24. 6. to 27. 7. 1957 with an interruption from 27. 6. to 4. 7. The duration of the cruise seems to be too long for calling it synoptic. But the sections were run continuously from north-east to south-west. Therefore, parts of the whole region are nearly crossed synoptically.

The results shown in Figures 18 and 19 are more surprising than those from August 1956 when a complicated situation should have been expected on account of the oceanic polar front (see DIETRICH, Ann. Biol., **13**). South-west of Iceland we expected to find very homogeneous Atlantic water, according to previous information based on widely spaced observations; but the narrow net of observations showed, however, that there are bands of water with low salinity having their origin in the north and reaching to the Reykjanes Ridge. The main band follows the Icelandic slope which is seen by comparison of the depth contours 500, 1000, and 1,500 m. It runs from N.W. to S.E., that means as a counter-current to the Irminger Current, influenced by the low salinity of the polar water. In about 62°N. there is also water of lower salinity, but we are not sure if it is a local disturbance or part of a counter-current.

The distribution of the surface salinity is an example of the far reaching effect of the polar front in forms of branches or eddies of polar water in the relatively warm Atlantic water rich in salinity.

G. DIETRICH

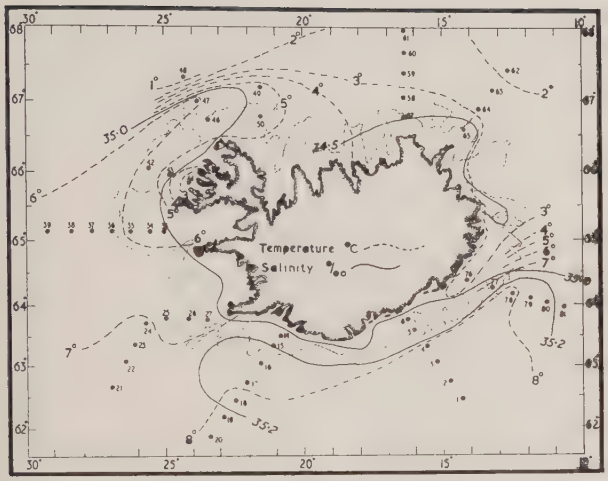


Figure 20. Temperature and salinity. Surface. 1. 4. 57 to 12. 5. 57.

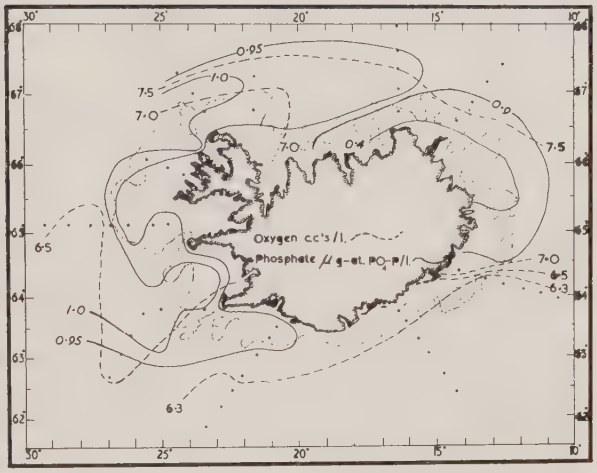


Figure 21. Dissolved oxygen and free phosphate. 10 m. 1. 4. 57—12. 5. 57.

Figure 22. Temperature and salinity. Surface. 28. 6. 57 to 22. 7. 57.

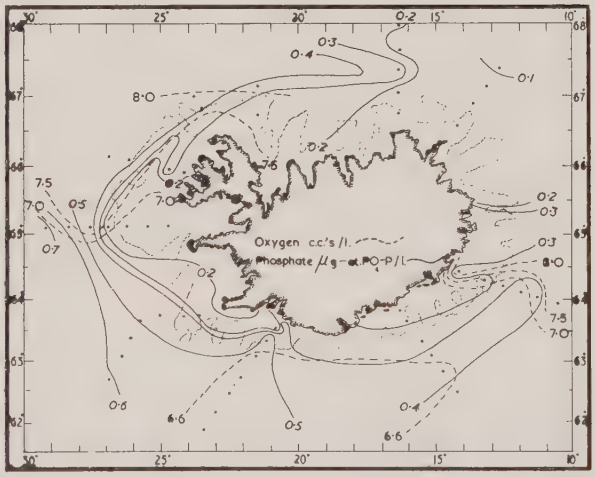


Figure 23. Dissolved oxygen and free phosphate. 10 m. 28. 6. 57—22. 7. 57.

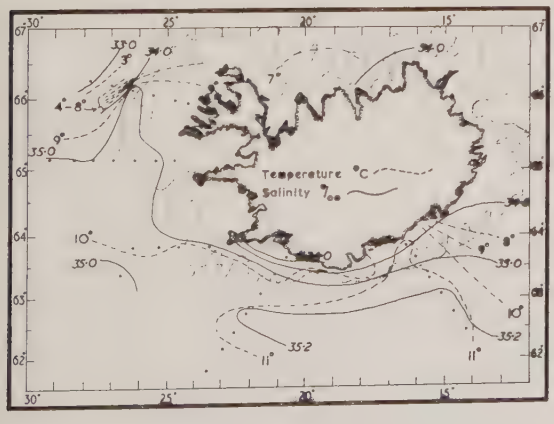


Figure 24. Temperature and salinity, Surface. 9. 9. 57 to 28. 9, 57.

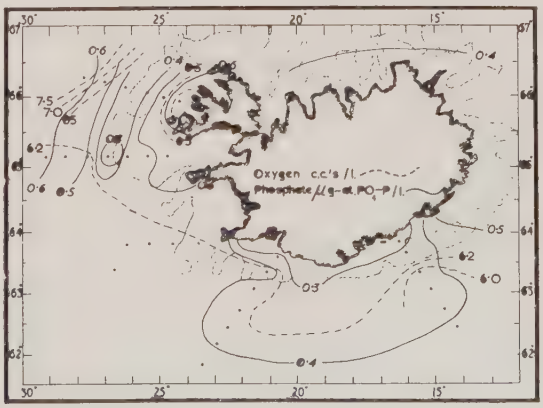


Figure 25. Dissolved oxygen and free phosphate. 10 m. 9. 9. 57—28. 9. 57.

Hydrographic Conditions in Icelandic Waters

(Figures 20–25)

The Scottish research vessel "Explorer" made three cruises in Icelandic waters in April/May, June/July, and in September 1957. Figures 20, 22, and 24 show surface temperature and salinity for the three cruises, while Figures 21, 23, and 25 show dissolved oxygen and free phosphate at the 10 m. depth. Numbers to the stations on the principal sections have been inserted in Figure 20 only.

The most saline conditions were found in the south (salinity $> 35.2‰$) in all three cruises, associated with the highest surface temperatures in April and September. In June the highest surface temperatures were recorded in the west.

In April/May there was no trace of Atlantic water (salinity $35.00‰$ and above) at any depth in the Langanes section (Stns. 62—65) nor in the Melrakka Sletta section (Stns. 57—61). Atlantic water was observed at all depths (0—210 m.) at Stn. 47 on the Kögur section and at the 20 m. and 50 m. levels at Stn. 50.

In June/July, although the $35.0‰$ isohaline failed to penetrate the Arnarfjörður section (Stns. 40—44) at the surface, Atlantic water was observed at subsurface levels at Stns. 49 and 58, and a vestige of it at the 75 m. level at Stn. 65 in the Langanes section. In September there was an increase of oceanic water across the Arnarfjörður section.

At Stn. 81 at the end of the Papey section, the entire column of Atlantic water that had been observed there in April, had been replaced in June by water of Arctic origin, with a bottom (400 m.) temperature of –0.17°C.

Phosphate values showed considerable depletion (0.3—0.5 µg.-at.PO_4–P/l.) down to the 20 m. level in June, and to the 30 m. level in September from the high values (0.95—1.0 units) recorded in April/May. Bottom values of phosphate in the oceanic water mass in the south and west lay between 1.0 and 1.1 units in April. In June there was a slight increase to 1.2 units in bottom values in the west.

Oxygen saturation values in the upper layers of the oceanic water mass which lay between 97—100% in April/May, rose to 110—114% in June, falling again to 104—109% in September.

At Stn. 1 an oxygen minimum value of 4.97 cc./l. (76% saturation) was observed at the 800 m. depth in April. In June a minimum value of 5.09 cc./l. (76% saturation) was found at the 1000 m. level, while in September the minimum value of 5.4 cc./l. (80% saturation) was found still lower at 1200 m. depth.

R. B. Burns

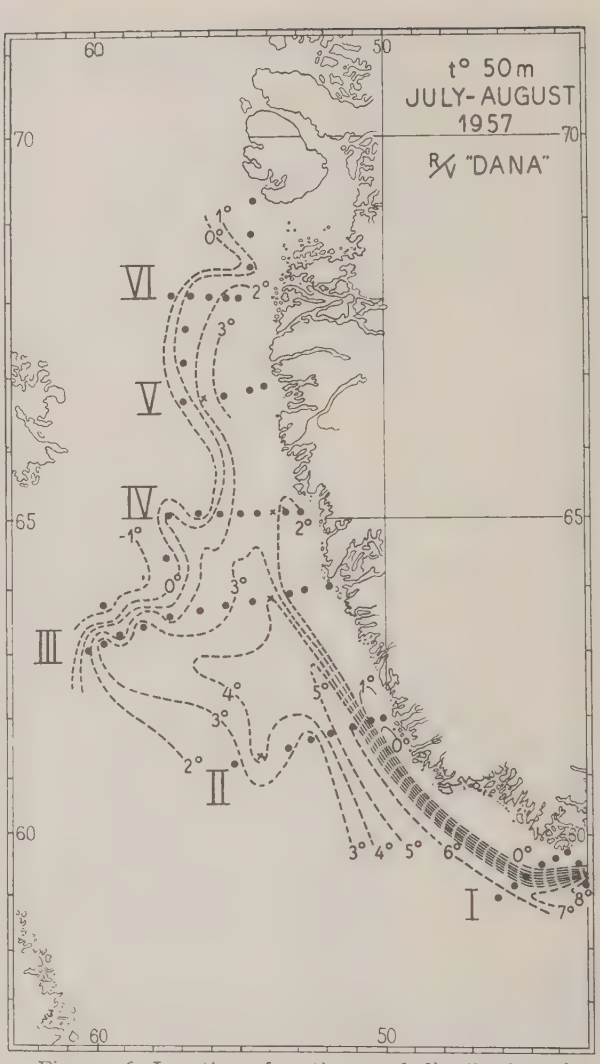


Figure 26. Location of sections and distribution of temperature at 50 metres.

Hydrographic Conditions in the Eastern Part of Labrador Sea and Davis Strait in 1957

(Figures 26–33)

In July and at the beginning of August the sections shown in Figure 26 were worked with the Danish R/V "Dana".

Off West Greenland the ice conditions were favourable with practically no "storis". The temperature distribution at 50 metres is shown in Figure 26. The sharp front between the Arctic and the Atlantic component of the West Greenland Current is clearly seen, especially off the southern part of West Greenland. Off Fylla Bank a branch of the West Greenland Current turns westward where the cold water masses of the Labrador Current are encountered. The temperature was

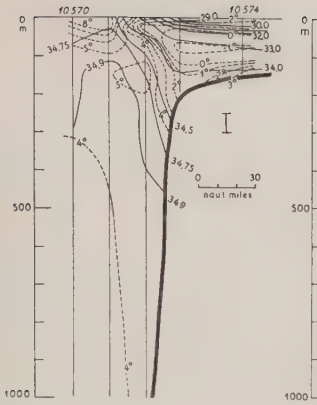


Figure 27. Section I off Cape Farewell 8.—9. Aug. 1957.

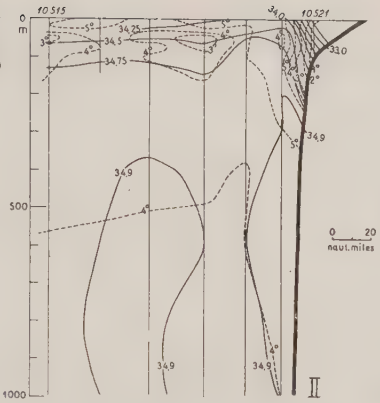


Figure 28. Section II off Frederikshåb 7.—8. July 1957.

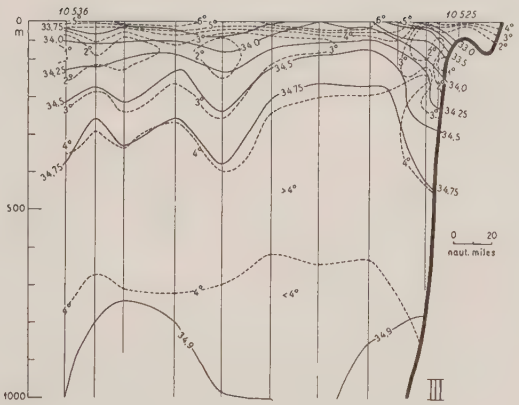


Figure 29. Section III across Fylla Bank 15.—17. July 1957.

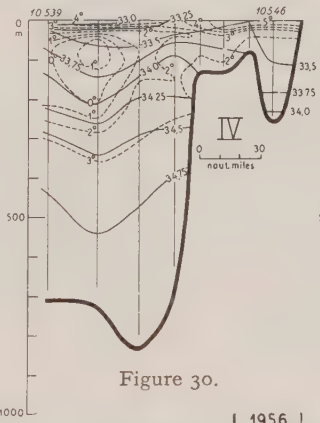


Figure 30. Section IV across Lille Hellefiske Bank 18.—19. July 1957.

Figure 30.

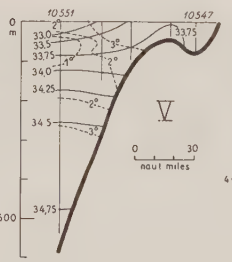


Figure 31. Section V across Store Hellefiske Bank 20.—21. July 1957.

Figure 31.

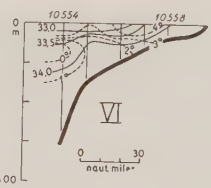


Figure 32. Section VI off Egedesminde 21.—22. July 1957.

Fig. 32.

about normal at 50 m. depth, but probably a trifle below normal in the southernmost and northernmost part of the area.

The hydrographic conditions are further illustrated by the sections I to VI (Figures 27—32). It is shown that the Arctic component of the West Greenland Current was weak except in the Cape Farewell section, and that the warm Atlantic component of the same current was well developed, especially in the region south of Fylla Bank.

At the beginning of April and in late June the Fylla Bank section was worked with the M/C "Adolf Jensen". In April the temperature over the shallow part of the bank was 0.15°C. at 40 m. depth and in June it was 1.35°C. The winter cooling seems not to have been very severe.

As in previous years a fixed station at the entrance to the Godthåb Fjord (64°07'N., 51°53'W.) was worked frequently throughout the year with the M/C "Adolf Jensen" and the M/C "Tornaq".

The variation of the temperature from November 1956 to February 1958 is shown in Figure 33. In

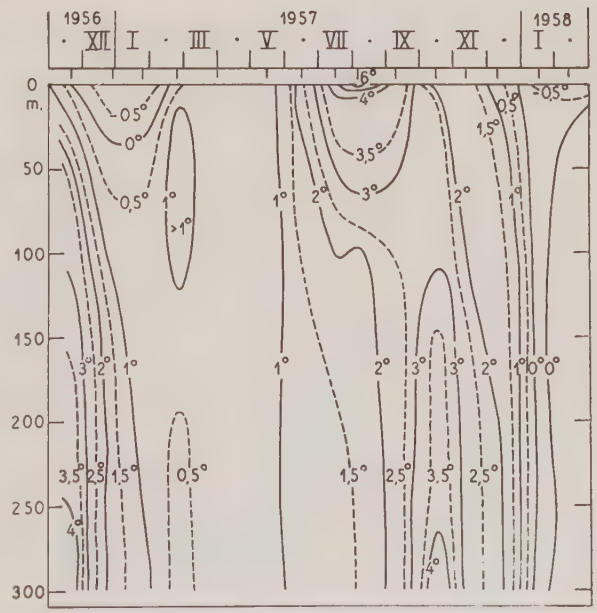


Figure 33. Variation of temperature at the entrance to Godthåb Fjord.

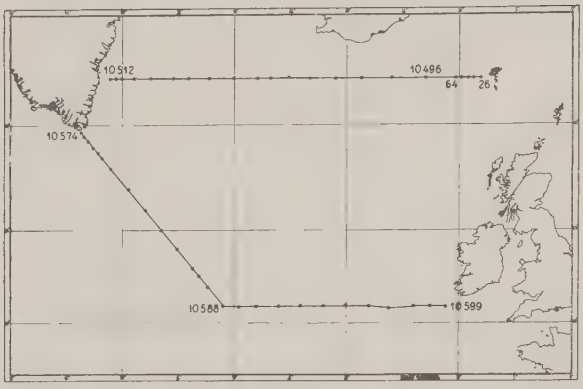


Figure 34. Location of sections.

March and April 1957 the temperature as usual was nearly uniform from surface to bottom. As the bottom temperature was positive throughout the year the winter cooling seems to have been less severe than usual. In November a strong inflow of warm bottom water took place; this is about a month earlier than usual.

In January 1958, the winter cooling was already very strong and negative temperatures were observed from surface to bottom.

F. Hermann

Sections Faroes to East Greenland and Cape Farewell to West Ireland

(Figures 34–36)

Two trans-Atlantic sections were worked from R/V "Dana", the section along 62°N. from the Faroes to East Greenland (Fig. 35) from 13. June to 3. July and from Cape Farewell to Ireland (Figs. 36a and b) from 9. to 18. August.

In the section from the Faroes to East Greenland a very thick layer of warm Atlantic water was observed between the Faroes and the Reykjanes Ridge. This layer of warm water has been increasing since about 1951 and the conditions are now nearly similar to those of 1938 and 1948. Near the slope off the Faroes lower temperatures and salinities near the bottom indicate overflow of deep water from the Norwegian Sea carried through the Faroe Bank Channel or over the Faroe-Iceland Ridge.

In the Irminger Sea the north-going Irminger Current present west of the Reykjanes Ridge had a greater extension than in most of the previous years. The south-going branch of the warm Irminger Current present off the Greenland slope seems to be about normal in extension. Its boundary to the East Greenland Polar Current was as usual very sharp and observed at the edge of the Greenland shelf. In the deep part of the Irminger Sea and especially to the west, cold bottom water was

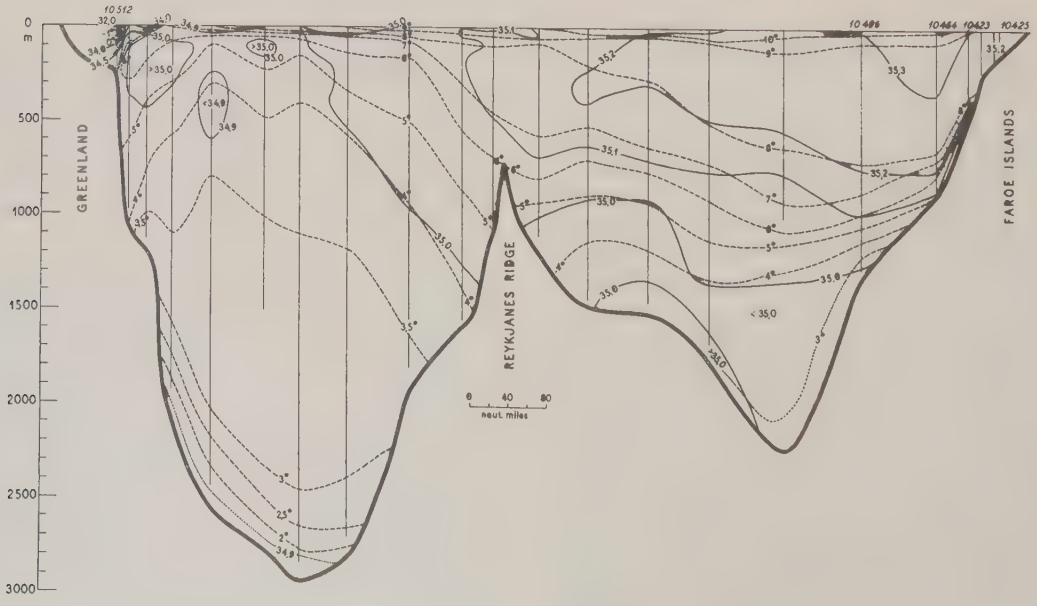
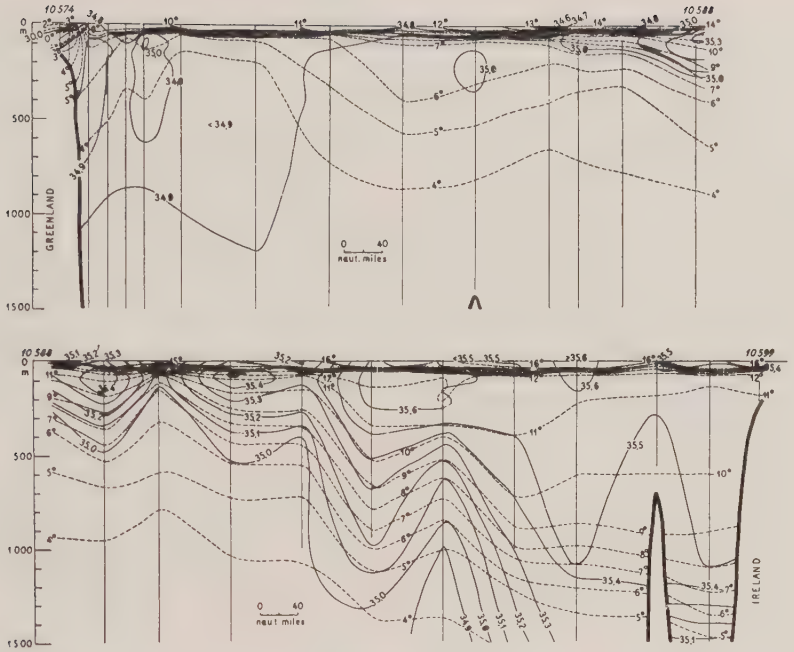


Figure 35. Section from the Faroes to East Greenland along 62°N. from 13. June to 3. July.



Figures 36a and b. Section from Cape Farewell to Ireland from 9. to 18. August.

observed, which must originate from the deep water of the Norwegian Sea overflowing the Iceland-Greenland Ridge.

The main features of the section from Cape Farewell to Ireland were similar to those found in 1954, 1955, and 1956. The front between the subarctic Labrador Sea water and the water masses of the North-East Atlantic Current was as usual at about 32°W., but was not as sharp as in the previous years.

F. HERMANN

Hydrographic Conditions in the South-Western Part of the Norwegian Sea, 1957

(Figures 37–41)

The important herring area, north of the Faroes and the Faroe-Shetland Channel were investigated in June by R/V "Dana" under the leadership of Mr. F. HERMANN.

Figures 37—39 show the temperature and salinity distribution at 0, 20, and 100 m. depth.

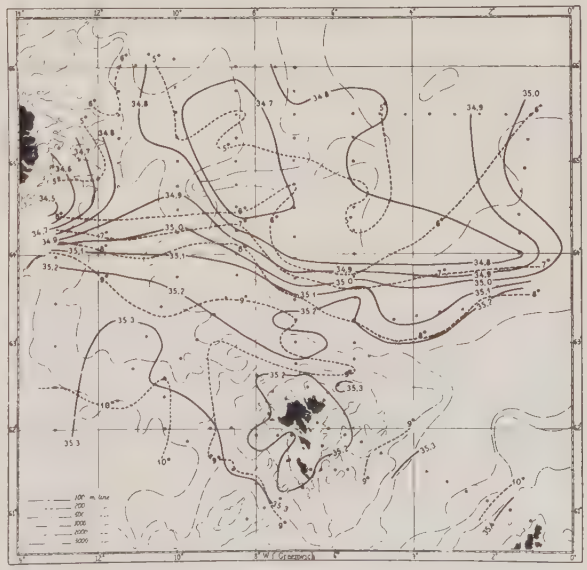


Figure 37. Temperature and salinity, surface, 3.—28. June 1957.

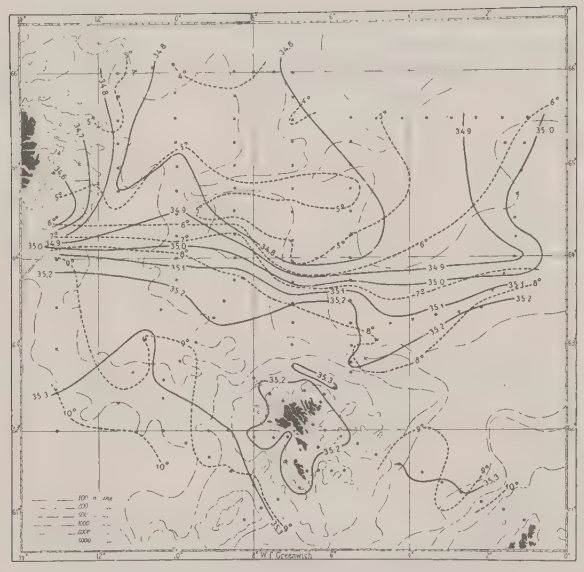


Figure 38. Temperature and salinity, 20 m., 3.—28. June 1957.

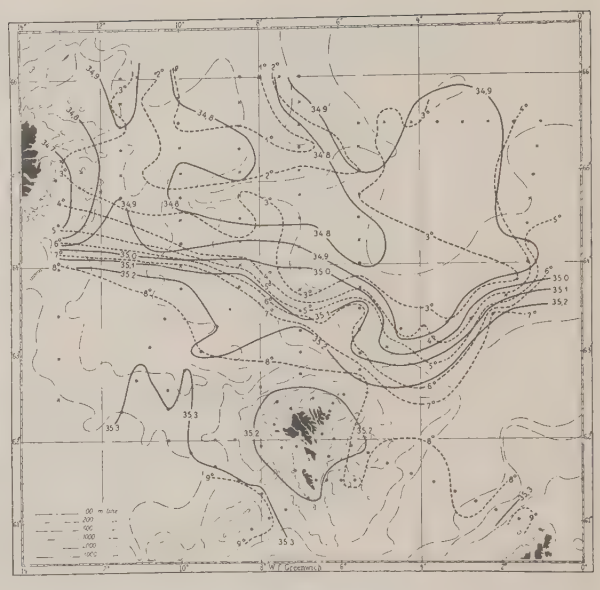


Figure 39. Temperature and salinity, 100 m., 3.—28. June 1957.

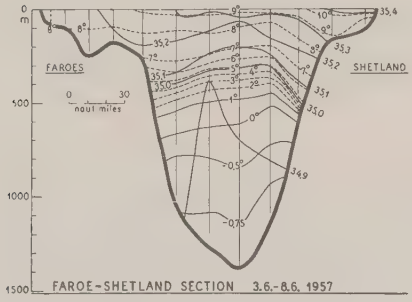


Figure 40. Faroe-Shetland section 4.—7. June 1957.

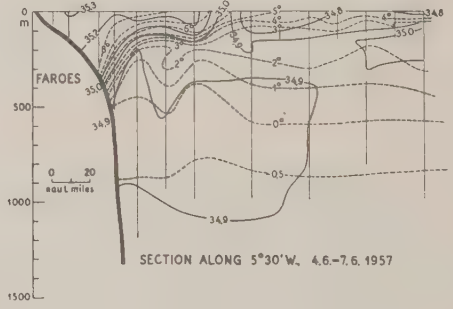


Figure 41. Section along 5°30′W., 3.—8. June 1957.

Figures 40 and 41 show the Faroe-Shetland section and a section along 5°30′W. and give further information on the conditions in the area.

The situation is rather similar to that of previous years. The boundary between the Atlantic water and the water of the East Icelandic Current is very pronounced and related to the bottom topography. The temperature of the East Icelandic Current is somewhat higher than usual and the border between the two water masses is situated more southerly than normal. This corresponds rather well to the Faroe-Shetland section which indicates a low inflow of Atlantic water.

KNUD P. ANDERSEN

Plankton

Unusual Distribution of Salps in Icelandic Waters in 1957

In the first half of September 1957 an unusual distribution of *Salpa fusiformis* was observed in Faxaflói from the research vessel "Ægir".

According to information from fishermen, the invasion of salps began at the end of July at the south-west coast and has most likely culminated in August in Faxaflói, where dense concentrations were observed at that time.

As far as known, such concentrations of salps have not been observed previously in these waters.

INGVAR HALLGRÍMSSON

Plankton Investigations from Aberdeen in 1957

(a) The Faroe-Shetland Channel Area

Phytoplankton

On the Faroe plateau in February the dominant species were *Chaetoceros atlanticus* and *Coscinodiscus* spp. but the deeper water between Faroes and Shetland contained no assessable phytoplankton. In June there was an overwhelming preponderance of diatoms over dinoflagellates with *Chaetoceros debilis* very abundant to the west and north of Faroes whilst *Rhizosolenia alata* f. *gracillima* occurred on the edge of the Scottish continental shelf as usual and associated with *Dolioletta* and *Arachnactis* larvae. The *Rhizosolenia* reached the North Sea via the north of Shetland during this month, and was still present west and north of Shetland in September but phytoplankton was poor in the centre of the Channel. *Ceratium tripos* was the dominant form on the Faroe plateau.

Zooplankton

February: *Calanus* was only poorly represented between the Butt of Lewis and Faroe Bank but occurred in moderate numbers in Faroese waters, between Faroe Bank and Faroe, and between Faroe and Shetland. The oceanic fauna at the western end of the Channel contained a proportion of Lusitanian species (*Vogtia, Bassia, Lensia fowleri*, etc.) but little of this reached the Faroe-Shetland line.

June: *Calanus* appeared in moderate numbers over the shelf to the north of Scotland and Shetland and was still present on Faroe Bank and in dense numbers about 100 miles north-west of Faroe, on the Faroe-Iceland Ridge and on the Faroe-Shetland line. It was poorly represented in the oceanic water lying over the deep water between the shelf and Faroe Bank. Here *Dolioletta gegenbauri* was extremely abundant, and particularly so at about 250 m. depth, but absent in the lower layers sampled at about 800 metres. A few had reached the Faroe-Shetland line but only at the eastern end. *Cosmetira* was present over the shelf at the southern entrance to the Channel but was not found in the Shetland area. On Faroe Bank and to the north the doliolids were absent but *Aglantha* was very abundant, and extended in numbers as far as the south side (but not across) the Faroe-Iceland Ridge; it was not common in the Shetland area.

September: *Calanus* was still present in numbers over the Scottish shelf north of the Hebrides and west of Shetland and in smaller numbers on Faroe Bank and east of Faroe. It was almost absent over the deep water between the Butt of Lewis and Faroe Bank. Although the fauna here was still definitely oceanic the doliolids were very much reduced and were absent from the Faroe-Shetland area. The fauna in this oceanic community still suggested a southern origin and included species such as *Iasis zonaria, Vogtia spinosa, Lensia fowleri, L. hotspur*, and *Tomopteris cavalli*, with numerous *Arachnactes, Sulculeolaria*, etc. *Salpa fusiformis* was strangely absent in contrast to the Icelandic area.

November/December: There was little change on the Butt of Lewis to Faroe line beyond the further reduction of the doliolids but there was little oceanic plankton on the Faroe-Shetland line. North of Faroe Bank the boreal influence was seen in the plankton with the absence of the southern species and the predominance of *Physophora*.

(b) Icelandic Waters

Phytoplankton

During the period April/May phytoplankton numbers were very low and the spring outburst had apparently not yet begun. The phytoplankton present was distributed over the shelf along the east and south coasts with *Thalassiosira gravida, Chaetoceros convolutus*, and *Chaetoceros debilis* as the most abundant species.

In the period June/July the densest of diatoms were over deep water west of the shelf and consisted mainly of *Chaetoceros debilis* whilst closer to the shelf *Thalassiothrix nitzschioides* was dominant. In the oceanic water to the south *Rhizosolenia*

styliformis dominated and merged into *Chaetoceros debilis* and *Ch. decipiens* in the east. In the east water dominated by *Rhizosolenia* spp. impinged on the northern coast. The shelf itself was poor in diatoms but was dominated by *Ceratium longipes* whilst the water off the shelf in the west and south was dominated by *Ceratium fusus*. Negligible quantities of dinoflagellates were found on the north and east coasts.

In September *Chaetoceros decipiens* and *Nitzchia seriata* were present over the shelf, particularly in the south-west, and *Rhizosolenia alata* f. *gracillima* was abundant to the north-west of Iceland. The oceanic water to the south and west was poor in diatoms but contained *Ceratium tripos*. *C. fusus* dominated in the areas rich in *Rhizosolenia* and also in the north-east.

Zooplankton

April/May: Crustaceous plankton, rich in *Calanus*, *Euchaeta*, and euphausids dominated the plankton west of Iceland, north of the Reykjanes Ridge, both on and off the shelf. Elsewhere—north, east, south-east, and south of Iceland, this rich plankton was present in the upper 100 metres but only over deep water; over the shelf plankton was poor except for fish eggs and *Mallotus* larvae near the Vestmann Is. Cod eggs and herring larvae were abundant in Faxa Bay. Halibut eggs were most common just to the north of Reykjanes Ridge. Oceanic plankton was sparse off the south-east and east coasts but was present south of the Reykjanes Ridge where a general cosmopolitan found off the North Atlantic was mixed with local and boreal species in the sub-surface layers over deep water. Boreal species were fauna of deep water round the rest of the coast and there appeared to be little exchange of water on and off the shelf.

June/July: The rich plankton of the spring had largely been replaced off the south and south-west of Iceland by oceanic plankton, but *Calanus*, etc. were still dominant off the south-east, north-west, and north-east coasts, off the shelf and between 250 and 100 m. depth but over deep water. There were large numbers of young fish off the N.W. coasts. A dense patch of *Evadne* was found on the shelf in the south-east. The oceanic plankton in the south was very distinct and dominated by *Aglantha* in immense numbers accompanied by other North Atlantic species such as *Clio pyramidata*, *Sulculeolaria biloba*, and a few *Salpa fusiformis* and *Dolioletta gegenbauri*. North of the Reykjanes Ridge *Aglantha* was much less abundant and was accompanied there by *Beroe*, *Turris*, and *Cyanea* in a community which extended round the North Cape and along part of the north coast, but not close inshore. North and east of Iceland there was no Atlantic plankton and the rich *Calanus* population continued. Again there was no evidence of exchange between waters on and off the shelf.

September: The summer conditions west of Iceland were ideal for the development of *Salpa fusiformis* which increased in such numbers as to dominate the plankton. It was found in relatively small numbers off the whole south coast west of 15° but only within 50 miles of the coast. North of Reykjanes Ridge, however, *Salpa fusiformis* had spread widely; it overflowed on to the shelf to flood the Faxa Bay area and had spread in great numbers to about 27°W. It had been carried also round the North Cape but its greatest numbers were found on the shelf, at all depths, west of Isafjarðar Sysla. Over the deep water to 27°W. it was confined to the upper 250 metres with a rich fauna of *Calanus*, and bathypelagic species, *Sagitta maxima* and *Eukrohnia hamata* below. North-east of Iceland none of this Atlantic fauna was found and there was a rich fauna of *Calanus*, euphausids, and *Sagitta elegans* over the deep water with a reduced crustaceous element over the shelf.

Interesting fish records from the plankton nets include one specimen of *Antimorra viola* (Goode and Bean) from 62°28′N., 14°23′W. on 6. April, two specimens of *Diplolychnis bifilis* Regan and Trewavas, one taken from 61°51′N., 23°20′W. on 9. April and the other from 61°51′N., 23°25′W., at almost the same place, on 4. July, and one specimen of *Trachyrhynchus murrayi* Gunther from 62°45′N., 22°04′W. on 8. April.

The planktonic evidence thus suggests a thrust of southern origin into the western entrance of the Faroe-Shetland Channel which did not have a great volume transport. A much greater thrust carried oceanic plankton of a quite different origin, from the open Atlantic, towards the south coast of Iceland. At first this was diverted by the Reykjanes Ridge but later it continued across the ridge to affect west and north-west Icelandic waters to and beyond North Cape.

J. H. Fraser

THE FISH

Halibut

Scottish Investigations

(Figures 42–43; Tables 5–6)

During 1957 F.R.V. "Explorer" collected data on halibut during two trips to Faroese waters and three trips to Icelandic waters.

The Faroe area

The two cruises were made in January (14.—24.) and December (2.—4.). In each of these months 24 one-hour hauls were made. On the January cruise most of the hauls were made in the area 62°00'N., 06°12'W., while in December the shelf north and south of Myggenæs was also worked. The depth of all hauls was between 90 and 125 m. The primary object of these cruises was the testing of gear so the hauls were not always directly comparable, but the majority were made with a 48 ft. V.D. trawl (cod-end mesh 90—100 mm.) usually with a small mesh cod-end cover.

The total length frequency distributions from each month's sampling are given in Table 5. The bulk of the catch is made up of only two year-classes, which in December-January are the 1+ and 2+ groups. The mean lengths and range for the various year-classes in each cruise are given below.

	January cruise		December cruise	
	Mean length		Mean length	
Year-class	cm.	Range	cm.	Range
1956	(10)	—	26.4	22—32
1955	28.1	24—32	40.1	34—46
1954	37.8	30—47	49.2	44—59
1953	47.5	40—57	—	—

There was no significant difference in length between males and females. The mean length increase in 12 months for the 1+ group was 12 cm. and for the 2+ group 11.4 cm. The numbers of each brood from 24 hauls were as follows:—

	January	December
1956 year-class	1	110
1955 ,, ,, ...	116	136
1954 ,, ,, ...	411	41
1953 ,, ,, ...	56	2
Others	9	1
Total	593	290

The 1+ year-class in December 1957 was present in about the same abundance as the 1+ class of the previous year, suggesting a similar level of recruitment for the two years. The average catches in January and December per 1-hour haul were 25 and 12 individuals respectively. The decline in numbers is due to a decrease in the good 1954 brood which at a mean length of over 49 cm. in December would be moving out of the area into deeper water.

Table 5.

Length of halibut caught by "Explorer" at Faroe

Length, cm.	January	December
<22	1	—
22	—	3
23	—	6
24	2	11
25	4	14
26	12	21
27	21	22
28	24	19
29	39	8
30	19	3
31	11	—
32	2	3
33	15	—
34	19	1
35	29	3
36	36	—
37	55	7
38	72	21
39	74	29
40	38	17
41	24	26
42	14	12
43	17	11
44	10	7
45	6	6
46	6	7
47	7	8
48	3	2
49	7	4
50	2	4
51	4	4
52	4	—
53	1	1
54	1	—
55	—	3
56	3	3
57	4	—
58	1	—
59	—	1
60	2	1
>60	4	2
Total	593	290

The Iceland area

(a) Trawling survey. A total of 81 half-hour hauls was made round Iceland, 25 in spring, 31 in summer, and 25 in autumn. The gear used was a 48′ V.D. trawl with 110 mm. mesh cod-end and fine mesh cover. The positions are shown in Figure 43. Halibut were caught in only 30 of the 81 hauls.

Table 6. Lengths of halibut caught by "Explorer" at Iceland

Length cm.	April ♂	April ♀	July ♂	July ♀	September ♂	September ♀	Total
<28	1/25 1/26	1/25 1/26	1/26	—	1/22	1/24	6
28 ...	—	—	2	—	—	—	2
29 ...	—	—	4	2	2	—	8
30 ...	—	—	4	1	3	2	10
31 ...	—	—	2	2	1	1	6
32 ...	—	—	5	2	7	4	18
33 ...	—	—	5	2	4	2	13
34 ...	—	—	3	1	6	7	17
35 ...	—	1	1	1	5	1	9
36 ...	—	—	1	1	3	7	12
37 ...	—	—	1	—	1	1	3
38 ...	—	—	—	—	1	1	2
39 ...	—	—	—	—	1	1	2
40 ...	—	1	—	—	2	1	4
41 ...	—	—	—	—	1	—	1
42 ...	—	—	1	2	4	4	11
43 ...	—	1	—	1	3	1	6
44 ...	—	1	1	1	2	1	6
45 ...	1	—	1	2	3	1	8
46 ...	1	—	—	—	1	—	2
47 ...	3	—	1	1	3	1	9
48 ...	1	1	2	2	—	3	9
49 ...	1	1	—	2	1	1	6
50 ...	—	—	2	1	—	1	4
51 ...	—	1	—	—	—	—	1
52 ...	—	—	—	1	—	—	1
53 ...	—	2	1	—	—	—	3
54 ...	—	—	2	2	—	1	5
55 ...	—	—	—	1	—	—	1
56 ...	—	—	1	—	1	1	3
57 ...	—	1	3	—	—	—	4
58 ...	1	—	—	1	—	—	2
59 ...	1	—	—	—	—	1	2
60 ...	—	—	—	—	—	—	—
61 ...	—	1	—	—	—	—	1
62 ...	1	—	—	—	—	1	2
63 ...	—	—	—	—	—	—	—
64 ...	—	—	—	—	—	1	1
65 ...	—	—	—	1	—	—	1
66 ...	—	—	3	—	—	—	3
67 ...	—	1	—	—	—	—	1
68 ...	—	—	—	—	1	—	1
69 ...	—	—	—	1	—	1	2
70 ...	—	1	—	—	—	—	1
>70 ...	—	—	1/86 1/91 1/101	1/73 1/75 1/77	1/74 1/90	1/79 1/135	10
	12	14	50	34	59	50	219

Most of the hauls gave less than 5 halibut per $^1/_2$ hour, and big catches were taken only in Faxa Bay (64°08′N., 22°23′W., depth 29 m., 57 halibut, 12. July) and at position 65°53′N., 24°03′ W. (42 m., 78 halibut, 19. September). The total size frequency distribution is given in Table 6. Of age-groups sufficiently numerous to give reliable averages, the mean length of the II+ group was in July ♂ 31.4 cm., ♀ 32.1 cm. and in September ♂ 33.4 cm. ♀ 34.4 cm.

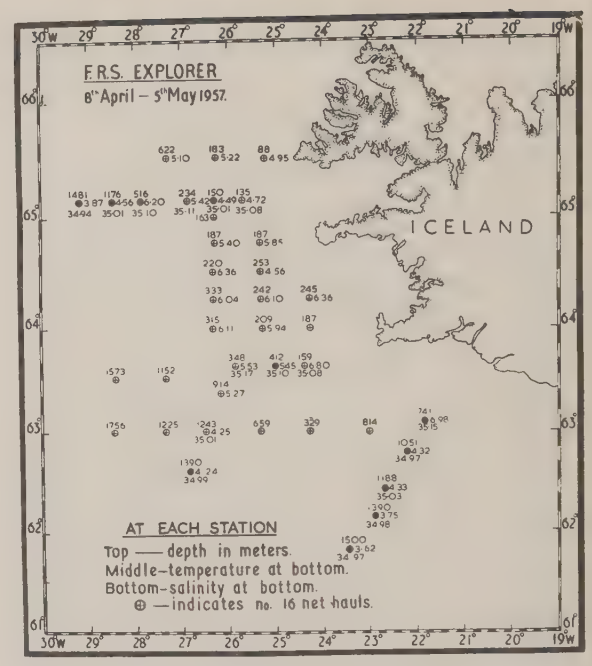


Figure 42.

(b) Spawning ground survey. Between 9. April and 5. May 38 stations were occupied in the Denmark Strait. Figure 42 shows the positions and depth of the stations, and where temperature and salinity observations were made the values are given. At 27 of the stations hauls of approximately one hour's duration were made with three 1 m. tow-nets of no. 16 mesh, towed between 600 m. and surface or, in shallow water, between bottom and surface. Altogehter 34 halibut eggs were taken at four stations from a total of 10 net hauls on 10.—11. April. The details are as follows:—

Position N.	Position W.	Total depth m.	Depth of haul m.	Number of eggs
63°00′	25°10′	659	600	3
			500	5
			400	3
63°00′	27°20′	1225	600	1
			500	1
			400	1
63°30′	28°25′	1573	600	6
			500	5
			400	8
63°30′	27°20′	1152	400	1

Most of the eggs had well developed embryos and had probably been in the water for 10—15 days. It should be noted that these eggs were taken over deep water to the south-west of the commercial fishing grounds. Our previous surveys have shown that currents move in from these deep stations and pass over the more shallow fishing

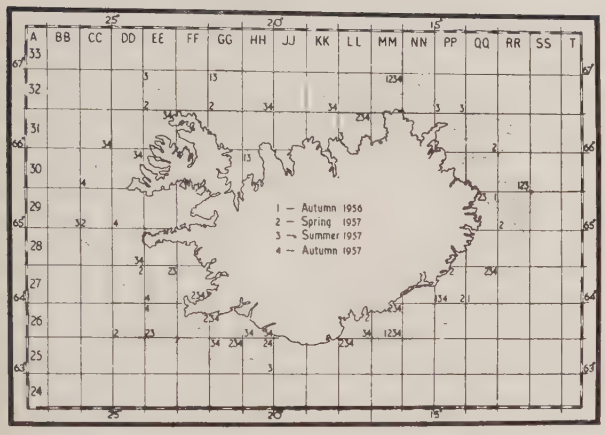


Figure 43. Posistions at which half-hour hauls for redfish were made by F.R.V. "Explorer" in four surveys.

grounds. It thus seems that the spawning which produced these eggs took place well off the shelf in the Irminger Sea "down-current" of the grounds. This agrees with the fact that fishermen seldom find ripe female fish and suggests that the spring halibut fishery in the Denmark Strait depends on fish which have moved in from deep water immediately after spawning and which later disperse to other grounds.

A. D. McIntyre

Redfish

Scottish Investigations

(Figure 43; Tables 7–8)

Between August 1956 and October 1957 F.R.V. "Explorer" made four trawling surveys in Icelandic coastal waters (depths between 29 and 207 m.) in which all redfish caught were counted and measured. Because of the present systematic uncertainties, these fish have not been specifically identified, but it is likely that the great majority, if not all over 30 cm., were *Sebastes marinus*. The station positions are shown in Figure 43. At each station one half-hour haul was made with a 48 ft. V.D. trawl with 110 mm. mesh cod-end cover. Length frequency distributions for all redfish caught on each cruise are given in Table 7. A total of 89 hauls were made on the four cruises, but of these only 28 had more than 35 redfish per half-hour haul. Separate length frequency distributions for each of these larger hauls are given in Table 8.

In the autumn of 1956 most of the fish were between 32 and 43 cm., although at MM 26 (off the south-east coast) a size group with a peak at 9 cm. was present. In spring 1957, 25 hauls were

Table 7. Length frequencies of redfish caught by "Explorer" on four cruises at Iceland

Date	31. 8. 56 – 5. 9. 56	4. 4. 57 – 12. 5. 57	28. 6. 57 – 22. 7. 57	10. 9. 57 – 28. 9. 57
No. of, Hauls	8	25	31	25
Length, cm.				
6	—	2	—	—
7	2	8	5	—
8	14	11	8	2
9	26	36	31	3
10	13	31	20	9
11	1	3	14	15
12	3	8	9	11
13	3	4	9	12
14	1	9	24	11
15	0	7	23	9
16	0	8	52	16
17	0	7	73	22
18	0	4	72	23
19	0	10	78	34
20	1	5	91	27
21	1	9	61	39
22	2	5	101	25
23	3	7	79	30
24	3	8	81	16
25	2	25	77	16
26	2	10	78	27
27	2	17	76	18
28	3	18	73	21
29	2	14	83	18
30	1	22	92	31
31	3	23	99	20
32	8	25	82	40
33	11	24	114	26
34	13	25	105	27
35	24	19	101	35
36	22	18	94	37
37	35	22	88	38
38	31	30	85	55
39	25	29	87	74
40	17	39	57	73
41	18	35	71	81
42	10	30	64	81
43	17	18	50	67
44	6	10	46	49
45	7	4	11	26
46	7	6	13	23
47	0	2	17	18
48	2	0	9	12
49	2	1	4	11
50	—	—	4	12
51	—	—	2	30
52	—	—	0	11
53	—	—	2	4
54	—	—	—	4
55	—	—	—	4
56	—	—	—	—
57	—	—	—	—
58	—	—	3	—
59	—	—	—	—
60	—	—	—	—
>60	—	—	1/65 1/70	—
Total	343	648	2520	1293

Table 8. Length frequencies of redfish in selected half-hour hauls by "Explorer" at Iceland

Cruise	Autumn 1956			Spring 1957				Summer 1957													Autumn 1957						
Area	QQ	MM	GG	LL	EE	DD	DD	LL	HH	GG[1]	GG	EE	DD	BB	CC	EE	EE	HH	KK	MM	EE	EE	DD	CC	CC	MM	HH
	27	26	32	25	27	27	29	25	25	25	26	27	28	29	31	31	32	32	32	32	26	20	28	30	31	32	25
cm.																											
6	—	—	—	1	—	1	—	—	—	—	-	[illegible]	—	-	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	2	—	6	—	1	—	—	—	—	—	—	—	4	1	-	—	—	[illegible]	—	—	—	—	—	—	—	—	—
8	—	14	—	10	—	1	—	—	—	—	—	—	1	7	—	—	—	—	[illegible]	—	—	—	—	—	2	—	—
9	—	25	—	26	2	1	1	2	—	2	—	—	1	25	1	—	—	—	—	—	—	—	1	—	—	—	2
10	—	13	—	19	1	1	—	6	—	1	—	—	1	9	—	—	—	—	—	1	—	—	1	—	1	—	4
11	—	1	—	1	—	1	—	9	—	1	—	1	—	—	—	—	—	—	—	1	3	—	4	—	—	—	7
12	—	2	—	6	—	—	—	7	1	—	—	—	—	—	—	—	—	—	—	1	3	—	1	—	—	3	3
13	—	1	—	3	—	—	1	1	2	1	—	1	—	1	1	—	—	1	—	1	—	—	2	1	—	6	3
14	—	—	—	2	—	1	—	1	3	1	—	1	—	11	—	1	—	1	—	5	—	—	1	—	—	3	6
15	—	—	—	1	—	3	1	1	5	2	1	—	2	11	1	—	—	—	—	—	—	—	1	—	—	1	6
16	—	—	—	1	—	6	—	1	12	1	1	5	6	17	—	—	—	—	—	6	3	—	2	—	—	6	2
17	—	—	—	2	1	3	—	1	19	4	—	17	7	13	—	2	1	—	1	7	1	—	6	—	1	—	13
18	—	—	—	—	1	2	—	—	19	2	4	15	11	11	—	1	—	—	1	6	3	2	8	—	—	2	15
19	—	—	—	1	6	1	—	—	12	1	9	24	14	4	—	4	1	—	1	7	—	1	11	—	—	1	20
20	—	—	—	—	3	1	—	—	22	2	17	18	12	1	—	8	1	1	—	9	3	—	6	—	—	1	13
21	—	—	—	—	7	—	1	—	11	0	18	14	5	1	1	1	—	—	—	6	7	6	1	1	—	2	19
22	—	—	—	—	4	—	—	—	21	3	43	12	3	—	—	4	—	—	—	12	3	2	4	—	—	2	17
23	—	—	—	—	4	—	—	—	14	—	31	7	5	—	—	6	—	—	1	14	4	1	4	—	—	3	10
24	—	—	—	—	6	1	—	—	23	1	27	11	1	1	—	3	—	1	1	11	—	1	3	—	—	1	6
25	—	—	—	—	12	5	—	—	17	1	11	9	2	—	1	4	2	1	3	24	—	6	1	—	—	3	3
26	—	—	—	—	4	3	—	—	8	2	11	12	4	—	1	16	1	2	—	20	4	12	4	1	2	3	—
27	—	—	1	—	6	1	6	—	6	—	6	11	2	—	1	16	8	3	2	19	3	3	2	3	1	3	—
28	—	—	1	—	5	5	3	—	4	2	1	5	6	—	2	17	10	5	—	17	1	—	4	2	2	7	—
29	1	—	—	—	2	8	2	—	—	—	—	7	3	1	3	25	17	7	—	15	—	2	4	3	1	4	—
30	1	—	—	—	1	9	5	—	1	2	—	3	5	1	1	26	14	11	2	19	2	3	10	6	6	3	—
31	—	1	2	—	2	11	4	—	1	1	—	3	11	1	3	30	14	9	3	16	—	3	1	4	3	6	—
32	1	—	5	—	—	19	2	—	—	—	—	3	10	4	1	16	10	15	3	13	—	2	23	4	2	9	—
33	—	1	10	—	—	16	3	—	2	1	1	7	9	4	2	15	26	23	2	15	2	3	9	3	2	4	—
34	—	2	10	2	1	10	—	—	3	—	—	4	10	1	4	10	15	36	1	13	4	3	10	1	2	6	—
35	5	2	16	—	2	8	1	—	1	—	—	3	9	2	—	7	26	20	5	10	5	4	12	8	3	2	—
36	1	2	19	—	—	8	1	—	10	3	—	2	4	2	2	5	22	18	5	10	9	4	8	3	9	3	—
37	3	7	24	—	—	8	2	—	15	6	—	—	6	4	2	3	21	7	6	8	4	3	4	18	4	—	4
38	6	4	20	—	2	12	4	—	15	6	2	1	11	11	4	3	14	3	4	7	7	5	9	15	6	2	6
39	7	5	13	—	—	17	1	2	15	9	—	1	13	6	2	1	8	4	5	8	11	9	18	10	5	—	12
40	4	5	8	1	1	19	8	2	8	5	—	2	5	9	3	2	8	5	3	2	4	10	21	15	7	1	10
41	8	4	6	2	3	11	10	—	11	10	2	7	13	7	3	—	11	1	—	1	3	15	16	14	9	—	20
42	5	1	3	1	1	15	8	1	9	5	1	3	20	7	6	2	1	1	1	3	1	21	26	5	8	—	14
43	6	3	7	—	3	8	4	—	11	4	—	1	13	9	4	1	3	1	—	1	3	11	13	—	21	—	16
44	3	2	1	—	—	6	1	1	5	13	2	1	12	3	1	—	2	1	1	—	4	11	8	1	9	—	16
45	3	2	2	—	—	—	1	—	4	4	—	—	1	2	—	—	—	—	—	—	—	7	2	1	4	—	12
46	3	2	2	—	1	—	—	1	1	4	1	—	3	—	—	1	1	1	—	—	6	1	—	—	5	—	10
47	—	—	—	—	—	—	—	1	3	7	—	—	1	—	2	—	1	1	—	—	1	3	2	—	—	—	12
48	2	—	—	—	—	—	—	—	2	4	—	—	1	—	—	—	—	—	—	2	2	1	2	—	—	1	6
49	—	2	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	8
50	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	10
51	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	20
52	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	10
53	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	4
54	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	-	—	—	—	—	—	—	—	—	4
55	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
57	—	—	—	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	—
58	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
59	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
60	—	—	—	—	—	—	—	-	-	[illegible]	-	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
>60	—	—	—	—	—	—	—	—	—	—	—	—	1/70	—	—	—	1/65	—	—	—	—	—	—	—	—	—	—
Total	59	103	150	85	81	223	70	38	318	112	190	211	244	190	53	232	240	179	51	312	110	155	265	119	115	88	347

[1]) 2 hauls.

made all round the coast. Redfish were not abundant, being present in numbers of less than 35 per half-hour in all but four hauls. Small fish, again with a peak at 9 cm., were still found mainly in the south-east (LL25). Other peaks occurred at 25 cm., at about 32 cm., and at 40 cm.

The summer survey, covering 31 stations, was the most extensive, and at 14 of the hauls comparatively large numbers of redfish (ranging from 38 to 315 individuals per half-hour) were caught. The peak of the small size group in the south-east had moved to 11 cm. but in this area catches were poor. Good catches were made from the Vestmann Islands round to the North Cape and also along the north coast. A small size group, with a peak at 9 cm., was found at BB29, and in this haul there were two other well marked peaks — one at 16 cm. and another at about 39 cm. Length frequency diagrams for most of the other areas, however, usually show only one or two main peaks in each haul. In the south-west and west the bulk of the catch was between 17 and 26 cm. while in the north-west and north mainly between 26 and 42 cm.

In the survey in autumn 1957 catches were again lower, only 7 of the 25 hauls having catches of more than 25 redfish per half-hour. In general, however, the size was greater than in the summer, 39% of all fish being 40 cm. or longer, while the comparable percentage for the summer survey was only 14%.

A. D. McIntyre

On the Sex Ratio of Redfish in East Greenland and Icelandic Waters in 1957

(Figure 44; Tables 9–13)

As has been pointed out by many authors, the sexes of redfish appear to be separated at certain times and localities.

On three cruises to the waters S.W. and W. of Iceland and to the East Greenland waters in May, June, and September 1957 respectively, a special emphasis was placed on this subject. Samples were collected from S.W. Iceland and East Greenland south to 60°N. (see Fig. 44). As the aim of the cruises was to search for redfish, suitable trawl stations were selected with that in mind; for this reason the material must be collected systematically. Thus systematic trawling at different depths was made on only one cruise (May) in the Reykjanes area and in the Víkuráll area.

In working up the material the mature fish were divided according to sex in order to find out whether there was a relationship between the sex composition of the catch and the propagation of redfish. For that purpose the young fish were eliminated. Therefore mature fish are defined in this paper as fish of 41 cm. length or more for males and 42 cm. or more for females. As these limits can be regarded as the maximum of the immature fish, all fish of smaller size are defined as immature.

In this paper the discussion will be limited to the samples from the East Greenland waters taken on all three cruises and those off Reykjanes, taken on two cruises.

The trawler fishery in the East Greenland waters is of a very recent date. In areas II and III (Fig. 44) commercial trawling was begun in 1956 and in area IV practically no commercial fishery has been carried out. Furthermore, in certain localities within the different areas, trawlings were made for the first time. It would seem of great interest to obtain data on the sex ratio from the region along East Greenland, as this region can be considered unexploited.

The area investigated in East Greenland waters was divided into four subareas, I to IV (Fig. 44). In all four subareas the common form of redfish predominated, but the *mentella* form was also recorded in areas I and III.

Table 9 shows the percentage sex composition of different hauls in subarea I in May, June, and September. In May, hauls were taken in depths from 140 to 280 fms. Males predominated in all hauls making 69% in average of the total, and 78% of mature fish only. The separation becomes more apparent with increasing depth. In June the separation of the sexes was not so pronounced as in May, but the samples from this area in June were too few to permit any definite conclusions to be drawn. In September hauls were taken at 150 to 215 fms. The males were still predominant, but the separation of the sexes was somewhat less than in May, the proportion of males being on the average 58% of the total, but 69% of mature fish only. No clear differences in the sex composition are found according to depths. But it should be remarked that, with the exception of one haul, they are all taken within the same 50 fms. range (150—200 fms.). In nearly all hauls of the cruises made to this area in May, June, and September, the percentage of small fish was rather high, 41 to 75%. In a few cases, almost exclusively small fish were caught. In May, a decrease in the quantity of small fish with increasing depth was established.

Table 10 shows the sex composition in subarea II. Looking at the average percentages for the different months, it is clearly seen that similar conditions as in subarea I obtain. In June, there seems to be

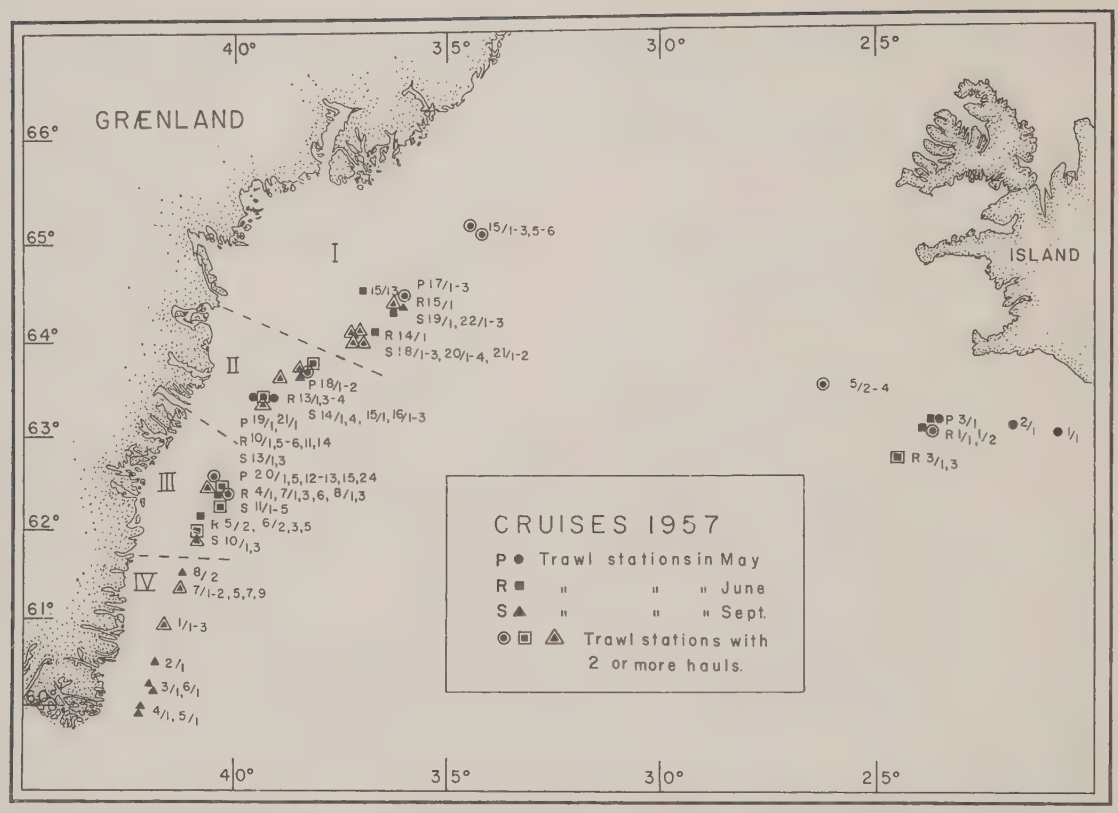


Figure 44. Chart showing the trawl stations. The numbers indicate station and haul as given in the tables.

Table 9. Sex ratio of redfish (*Sebastes marinus*) in subareas I—IV in East Greenland waters

Month	Station Nos.	Depth in fathoms	Number	% of total ♂♂	% of total ♀♀	% of mature fish ♂♂	% of mature fish ♀♀	Small fish in % of total
May	P 57—17/3	140	120	52.5	47.5	60.0	40.0	58.3
	,, 17/1	155	36	75.0	25.0	75.0	25.0	44.4
	,, 15/1	175	153	74.5	25.5	90.3	9.7	52.9
	,, 15/2	170—180	165	60.0	40.0	70.9	29.1	37.6
	,, 15/3	170—180	100	68.0	32.0	82.1	17.9	44.0
	,, 15/5	240	159	80.5	19.5	85.3	14.7	18.9
	,, 15/6	280	146	71.9	28.1	81.7	18.3	28.8
			879	68.9	31.1	77.9	22.1	40.7
June	R 57—15/3	130—110	377	46.7	53.3	75.0	25.0	99.2
	,, 15/1	150	152	62.5	37.5	75.5	24.5	38.2
	,, 14/1	205	50	50.0	50.0	66.7	33.3	88.0
			579	53.1	46.9	72.4	27.6	75.1
September	S 57—19/1	150	262	52.7	47.3	76.2	23.8	92.0
	,, 22/3	150	748	51.1	48.9	57.1	42.9	76.7
	,, 22/1	155	525	60.6	39.4	66.8	33.2	53.0
	,, 22/2	165	372	49.2	50.8	62.3	37.7	81.5
	,, 20/3	165—170	412	59.7	40.3	61.3	38.7	35.4
	,, 20/4	170	221	87.8	12.2	90.1	9.9	13.1
	,, 20/2	175	568	55.1	44.9	68.6	31.4	70.3
	,, 21/2	178—185	415	56.6	43.4	70.4	29.6	67.5
	,, 18/1	180—185	114	59.7	40.3	73.0	27.0	47.7
	,, 20/1	185	405	60.7	39.3	76.4	23.6	64.4
	,, 21/1	185—190	277	50.9	49.1	50.3	49.7	44.8
	,, 18/2	185—195	117	57.3	42.7	82.9	17.1	64.4
	,, 18/3	205—215	161	54.7	45.3	61.8	38.2	65.8
			4,597	58.2	41.8	69.1	30.9	59.7

Table 10. Sex ratio of redfish (*Sebastes marinus*) in subareas I—IV in East Greenland waters

Month	Station Nos.	Depth in fathoms	Number	% of total ♂♂	% of total ♀♀	% of mature fish ♂♂	% of mature fish ♀♀	Small fish in % of total
	P 57—18/1	125	147	67.3	32.7	71.6	28.4	30.6
	,, 19/2	125—130	131	79.4	20.6	88.0	12.0	23.7
May	,, 21/1	180	215	65.1	34.9	89.8	10.2	59.1
	,, 19/1	185—190	143	67.8	32.2	71.9	28.1	20.3
			636	69.9	30.1	80.3	19.7	33.4
	R 57—13/1	115	144	54.2	45.8	59.1	40.9	38.9
	,, 13/3	120	103	68.9	31.1	90.7	9.3	58.3
	,, 13/11	120	120	68.3	31.7	71.4	28.6	12.5
	,, 13/9	120—125	161	62.1	37.9	73.8	26.2	50.3
	,, 13/4	125—130	141	73.0	27.0	79.3	20.7	14.8
			669	65.3	34.7	74.9	25.1	34.2
June	,, 10/11	165—170	114	38.6	61.4	61.9	38.1	81.6
	,, 10/12	165—170	88	50.0	50.0	58.1	41.9	64.8
	,, 10/5	170—180	210	47.1	52.9	63.0	37.0	87.1
	,, 10/6	170—180	166	45.8	54.2	50.0	50.0	63.9
	,, 10/1	170—180	105	52.4	47.6	50.0	50.0	96.2
			683	46.8	53.2	56.6	43.4	78.7
			1,352	56.0	44.0	65.7	34.3	56.8
	S 57—16/2	115—120	334	65.0	35.0	66.8	33.2	15.3
	,, 16/3	120	196	54.6	45.4	59.1	40.9	33.9
	,, 16/1	120	359	68.0	32.0	68.6	31.4	37.1
	,, 15/1	125	528	46.6	53.4	46.0	54.0	38.5
September	,, 14/4	125	93	92.5	7.5	92.5	7.5	—
	,, 14/1	150	244	48.0	52.0	73.3	26.7	87.7
	,, 13/3	165	405	65.4	34.6	77.3	22.7	44.2
	,, 13/1	170	390	57.1	42.9	54.6	45.4	69.2
			2,549	62.1	37.9	67.3	32.7	56.5

a relation between depth and sex composition of the fish. Half of the hauls were taken at depths of 115 to 130 fms. and the other half at 165 to 180 fms. At the lower depths (115 to 130 fms.) the males were in majority, making 65% of the total and 75% of the mature fish. On the other hand, the males made less than one half of the total in the hauls taken at depths of 165 to 180 fms., but little more than half of the mature fish. In September no clear relation between sex ratio and depth can be defined. It is worth noticing that in June the percentage of small fish was much greater (79%) at depths of 165 to 180 fms. than at 113 to 130 fms. (34%). Similar conditions were found in September: 67% small fish at depths of 150 to 170 fms. but 31% at 115 to 125 fms.

The sex ratio for subarea III is shown in Table 11. In May the sexes were more mixed in this area than in areas I and II. The sex composition in subarea III seems to be constant during all three months for mature fish, a small increase, however, can be established for the total. In May, hauls were made at depths of 140 to 240 fms., but no relation between depth and separation of the sexes was found. In June, hauls were made at depths of 90 to 215 fms. but a clear relation between depth and sex composition could not been found. Considerable differences appeared between the different hauls. It is worth mentioning that there are noticeable differences in the sex composition of different hauls at the same station and at the same depth (e.g., St. R57—6/2 and 6/3). In September hauls were taken at depths of 100 to 205 fms. A tendency to greater separation of the sexes with increasing depth was noticed (at depths of 100 to 150 fms. males made 62% of the total and 65% of the mature fish, but at greater depths 75% and 77% respectively). In May and June the small fish were equally represented (on the average about 45% of the total) and similar to subareas I and II (with the exception of June in subarea II). In September, however, the small fish were by no means as numerous as in May and June (21%), but in this respect there were great differences between the hauls. Only in May a considerable decrease of small fish with increasing depth could be established (at depths of 140 to 175 fms. 50% on the average, but at 205 to 240 fms. 23%). Thus, in June, small fish were relatively few at shallower depths, absent, however, at the greatest depths. The opposite was

Table 11. Sex ratio of redfish (*Sebastes marinus*) in subareas I—IV in East Greenland waters

Month	Station Nos.	Depth in fathoms	Number	% of total ♂♂	% of total ♀♀	% of mature fish ♂♂	% of mature fish ♀♀	Small fish in % of total
	P 57—20/13	140—160	85	52.9	47.1	80.6	19.4	63.5
	,, 20/12	165	102	54.9	45.1	71.4	28.6	58.8
	,, 20/1	170	210	57.6	42.4	65.9	34.1	58.1
May	,, 20/24	170—175	146	56.2	43.8	66.7	33.3	38.4
	,, 20/15	205	108	65.7	34.3	72.3	26.6	19.4
	,, 20/5	230—240	231	57.6	42.4	61.2	38.8	26.4
			882	57.5	42.5	69.7	30.3	44.1
	R 57— 8/3	90—100	221	71.1	28.9	87.9	12.1	28.5
	,, 8/1	125	77	58.4	41.6	61.3	38.7	59.7
	,, 5/2	125—145	151	58.9	41.1	68.5	31.5	51.7
	,, 6/5	150	101	52.0	48.0	65.1	34.9	58.4
	,, 6/3	160—170	133	60.9	39.1	66.7	33.3	27.8
June	,, 6/2	170	101	44.6	55.4	39.7	60.3	32.7
	,, 4/1	170	100	58.0	42.0	68.3	31.7	59.0
	,, 7/1	205	102	61.8	38.2	68.3	31.7	59.8
	,, 7/3	200—210	115	69.6	30.4	77.0	23.0	35.7
	,, 7/6	210—215	100	75.0	25.0	75.0	25.0	—
			1,201	61.0	39.0	67.8	32.2	45.9
	S 57— 8/2	100	525	48.6	51.4	65.9	34.1	74.9
	,, 7/9	110	295	58.6	41.4	59.8	40.2	12.2
	,, 7/5	120	205	63.9	36.1	65.6	34.4	10.7
	,, 11/5	120	333	55.3	44.7	55.2	44.8	33.6
	,, 7/7	130	98	63.3	36.7	63.8	36.2	40.1
	,, 10/1	135	70	68.6	31.4	67.2	32.8	12.9
September	,, 7/2	130—140	172	72.7	27.3	73.1	26.9	0.6
	,, 10/3	130—140	243	70.0	30.0	73.3	26.7	19.8
	,, 11/4	140—160	332	53.0	47.0	63.7	36.3	52.7
	,, 7/1	155	143	69.9	30.1	69.7	30.3	0.7
	,, 11/1	170	401	80.5	19.5	83.6	16.4	14.2
	,, 11/3	185	509	72.3	27.7	77.6	22.4	31.6
	,, 11/2	205	397	76.8	23.2	78.5	21.5	8.3
			3,723	65.6	35.4	69.0	31.0	21.3

Table 13. Sex ratio of redfish (*Sebastes mentella*) in the Reykjanes area

Month	Station Nos.	Depth in fathoms	Number	% of total ♂♂	% of total ♀♀	% of mature fish ♂♂	% of mature fish ♀♀	Small fish in % of total
	P 57—5/4	200	57	38.6	61.4	36.2	63.8	17.5
	,, 5/3	250	134	29.9	70.1	19.0	81.0	25.4
	,, 4/4	275	115	19.1	80.9	13.7	86.3	6.1
	,, 4/1	280	162	20.4	79.6	11.6	88.4	20.4
	,, 4/5	285	150	18.7	81.3	12.6	87.4	15.3
	,, 5/2	310	82	39.0	61.0	36.8	63.2	17.1
May			700	27.6	72.4	21.7	78.3	17.0
	,, 1/1	340	198	65.2	34.8	64.6	35.4	3.0
	,, 3/1	340—360	215	57.2	42.8	55.3	44.7	15.8
	,, 2/1	350	235	71.9	28.1	68.0	32.0	4.3
			648	64.8	35.2	62.8	37.4	7.7
			1,348	40.0	60.0	35.3	64.7	13.9
	R 57—1/1	260	185	33.5	66.5	32.4	67.6	6.5
	,, 2/1	270	119	47.9	52.1	46.5	53.5	4.2
June	,, 3/1	270	100	61.0	39.0	63.0	37.0	8.0
	,, 3/3	270	126	50.0	50.0	50.9	49.1	11.1
			530	48.1	51.9	48.2	51.8	7.5

Table 12. Sex ratio of redfish (*Sebastes marinus*) in subareas I—IV in East Greenland waters

Month	Station Nos.	Depth in fathoms	Number	% of total ♂♂	% of total ♀♀	% of mature fish ♂♂	% of mature fish ♀♀	Small fish in % of total
September	S 57—3/1	120	126	77.0	23.0	78.1	21.9	2.4
	,, 1/1	125	100	58.0	42.0	63.4	36.6	29.0
	,, 1/2	125	154	70.8	29.2	77.7	22.3	21.4
	,, 4/1	125	231	58.4	41.6	66.7	33.3	24.7
	,, 1/3	140	226	73.0	27.0	79.3	20.7	24.3
	,, 2/1	140	272	51.1	48.9	51.1	48.9	—
	,, 5/1	140	286	66.1	33.9	66.4	33.6	1.1
	,, 6/1	150	255	77.7	22.3	77.8	22.2	2.8
			1,650	66.5	33.5	70.1	29.9	15.1

true for the lesser depths in September when the small fish were numerously represented (75% at 100 fms).

From subarea IV, samples exist from September only. Here the conditions were almost identical to subarea III at the same time. Hauls were taken at depths of 120 to 150 fms., and no relation between depth and sex composition was found. In this area the small fish appeared less numerous than in subarea I to III.

In the Reykjanes area the *mentella* form only was caught, except in one haul where both forms were present; however, the *marinus* form will not be discussed here. Hauls were taken at depths of 200 to 360 fms. As seen in Table 13, there are great differences between the sex composition according to depths. At depths of 200 to 310 fms. the females made 75% of the total and 78% of the mature fish, while at depths of 340 to 360 fms., the situation was reversed, the males predominating with 65% of the total and 63% of the mature fish. Perhaps these differences are, to some extent, due to the location of the stations. The small fish were more numerous in the shallower depths. In June, hauls were only taken at depths of 260 to 270 fms.; the sexes were then equally represented in the hauls.

The large quantities of small and very small redfish frequently caught on the East Greenland shelf provide an evidence that these areas are probably important nursing grounds for redfish.

These data show that great variations in sex composition frequently occur in different hauls within a small area, e.g., at P57, 1:3, as opposed to P57, 3:5. Samples taken from marketed redfish may thus be misleading even if they are taken from the landings of a single ship.

As seen in the tables, the sex ratio may differ both with depths and localities. On the basis of the present material, however, it is impossible to ascertain how the sex composition may change with time, although there appears to be some tendency for increased mixing in most areas from May to June and in September. However, the investigations should be carried on throughout a year in order to establish the extent of the separation of the sexes during the year.

Jakob Magnússon

Danish Catches of Redfish (*Sebastes marinus*) in West Greenland Fjords

(Tables 14–15)

In Godthåb Fjord (64°25'N., 50°19'W.) hauls with shrimp-trawl for redfish were made at different times of the season of 1957. A total of ten hauls was made, distributed over eight months. The total catch of redfish amounted to 14,282 fish all of which were measured. Otoliths were taken of a number of the redfish.

Measurements of redfish caught in shrimp trawl in this locality have been going on regularly since 1952.

In Tunugdliarfik Fjord (60°56'N., 45°47'W.) 1,293 redfish taken with the shrimp trawl were measured. A total number of seven hauls was made in January, February, and March. Samples of otoliths were collected.

P. M. Hansen

Table 14. Length frequencies of redfish taken with the shrimp trawl by M/C "Adolf Jensen" in Godthåb Fjord, 64°25′N., 50°19′W.

Date, 1957	Number of hauls	Length in centimetres 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan.	1	1	1	27	206	330	144	81	84	100	153	150	99	95	94	88	70	67	72	36	58
Feb.	1	—	15	27	263	858	531	121	159	120	196	231	189	104	142	146	121	72	76	57	44
March	1	—	24	52	155	838	607	159	121	118	166	209	188	133	124	116	96	81	62	58	37
April	1	—	6	30	22	147	310	148	61	68	71	121	116	76	29	31	39	14	14	9	6
July	2	—	—	2	—	5	24	33	18	15	21	36	87	99	62	46	86	73	45	42	28
Oct.	2	—	—	—	7	5	9	42	27	14	21	29	33	54	43	29	50	64	58	51	33
Nov.	1	—	—	—	9	5	9	24	22	14	19	21	39	35	29	38	50	48	36	38	25
Dec.	1	—	—	2	17	12	6	38	37	22	16	18	16	32	31	25	48	49	37	44	24

Date, 1957	Number of hauls	Length in centimetres 25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	>40	Number of fish
Jan.	1	89	105	86	63	36	41	20	27	32	37	16	11	5	5	3	3	6	2541
Feb.	1	71	62	61	48	32	11	8	5	11	7	—	2	5	—	3	3	2	3803
March	1	32	39	24	15	8	3	5	—	7	4	2	4	4	4	4	3	6	3508
April	1	2	5	11	9	1	6	8	9	12	18	25	20	20	16	12	9	27	1528
July	2	23	30	32	25	12	7	2	2	5	5	8	4	8	13	6	3	26	933
Oct.	2	34	34	34	27	22	10	6	4	5	6	11	6	6	5	7	4	5	795
Nov.	1	20	18	14	13	11	—	4	1	4	5	5	2	1	5	3	2	7	576
Dec.	1	22	17	11	10	8	11	1	5	4	5	6	5	8	1	3	2	5	598

Table 15. Length frequencies of redfish taken with the shrimp trawl by M/C "Immanuel" in Tunugdliarfik Fjord, 60°56′N., 45°47′W.

Date, 1957	Number of hauls	Length in centimetres 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan.	1	—	—	—	—	6	9	4	6	11	8	4	9	4	4	2	3	—	—	2	—
Feb.	4	—	4	9	22	69	104	65	62	48	38	47	65	46	24	14	10	11	13	6	8
March	2	5	19	18	28	47	59	38	34	18	15	3	14	17	15	13	3	7	7	4	—

Date, 1957	Number of hauls	Length in centimetres 25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	>40	Number of fish
Jan.	1	1	—	1	—	—	1	—	1	3	—	1	3	—	3	1	1	1	89
Feb.	4	4	2	7	4	5	2	8	11	7	6	8	7	6	2	3	2	12	761
March	2	4	3	2	2	2	4	5	7	4	9	7	8	4	4	5	4	5	443

Wolffish

Spotted Wolffish (*Anarhichas minor*)

(Figure 45)

Experimental fishery in three different localities, Søndre Upernavik (72°08′N., 55°28′W.), Disko Fjord (69°28′N., 54°07′W.), and Holsteinsborg (66°55′N., 54°00′W.) showed a decrease in size from south towards north. This appears distinctly from the following average lengths: Søndre Upernavik, 4.5 kg.; Disko Fjord, 7.5 kg.; and Holsteinsborg, 9.5 kg. It is also evident from the length curves shown in Figure 45. This indicates that the wolffish grow up in the north, from where they later on move southwards to the spawning grounds.

P. M. Hansen

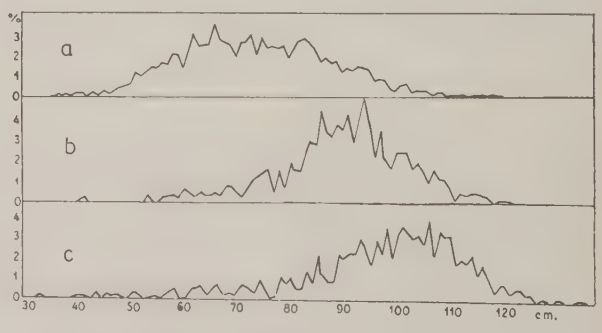


Figure 45.

a. Søndre Upernavik, July 1957, 2694 specimens.
b. Disko Fjord, 2. August 1957, 746 specimens.
c. Holsteinsborg, Sukkertoppen, and Godthåb Districts and Store Hellefiske Bank, August 1956, 786 specimens.

Rare Fish from Distant Northern Seas Area
Germany

A. Records of the Institut für Seefischerei, Hamburg

The Institut für Seefischerei, Hamburg, received in 1957 a rather high number of mostly bathypelagic fish from East Greenland, which were found in the stomachs of cod samples brought home by commercial trawlers for investigations of the maturity stages. We only check the species which are either new in the East Greenland fauna or rarely recorded, and not mentioned in the list given by KOTTHAUS & KREFFT in Ber. Deutsch. Wiss. Komm. Meeresforsch., **14**, 3, pp. 169—191, 1957. There are, however, a few records from West Greenland. The dates shown are those of the landings, unless otherwise stated; the length measurements represent the total length to the next cm. or mm., respectively, unless given in standard length.

Alepisaurus ferox Lowe 1835

August 1957, Faeringehavn, only some photographs were available of a large specimen which was shown to Prof. VON BRANDT in the cold-storage plant of the "Nordafar".

Aphanopus carbo Lowe 1839

1. 5. 1957, Anton Dohrn Bank, 1 ♀, 108 cm. First record for Greenland waters.

Bathylagus cf. atlanticus Goode & Bean 1878[1])

15. 4. 1957, Anton Dohrn Bank, 2, 146 and 165 mm. in standard length,
1. 5. 1957, Anton Dohrn Bank, 2, badly mutilated,
4. 6. 1957, Anton Dohrn Bank, 1, abt. 130 mm. standard length,
5. 10. 1957, Anton Dohrn Bank, 2, abt. 145 and 160 mm. standard length,
12. 11. 1957, Anton Dohrn Bank, 2, 138.5 and 186 mm. standard length,
all from stomachs of *Gadus callarias*.

Benthosema glaciale (Reinhardt 1837)

18. 8. 1957, Fiskenaes Bank, 7, abt. 45—56 mm.,
5. 10. 1957, Anton Dohrn Bank, 1, 75 mm.,
all from stomachs of *Gadus callarias*.

Borostomias cf. macrophthalmoides Koefoed 1956[1])

5. 10. 1957, Anton Dohrn Bank, 1, 254.8 mm. in standard length,
from the stomach of *Gadus callarias*.

Chauliodus sloanei sloanei Schneider 1801

4. 6. 1957, Anton Dohrn Bank, 1, abt. 22 cm., from the stomach of *Gadus callarias*. First record from Greenland waters.

Gaidropsarus argentatus (Reinhardt 1838)

caught on 15. 8. 1957, Frederikshavn, 7, 65—75 mm.,
caught on 18. 8. 1957, Fiskenaes Bank, 2, 69 and 74 mm.,
all from stomachs of *Gadus callarias*.

Gonostoma elongatum Günther 1878

15. 4. 1957, Anton Dohrn Bank, 1, abt. 17 cm. (tail broken),
from the stomach of *Gadus callarias*. First record from Greenland waters.

Lampadena braueri Zugmayer 1914

12. 11. 1957, Anton Dohrn Bank, 2, 119.7 and abt. 125 mm. standard length,
from stomach of *Gadus callarias*. First record from Greenland waters.

Lampanyctus crocodilus (Risso 1810)[2])

15. 4. 1957, Anton Dohrn Bank, 5, 144—162 mm.,
? 27. 4. 1957, Angmagssalik, 1 which was too mutilated for determination of the species,
1. 5. 1957, Angmagssalik, 7, 63—175 mm.,
1. 5. 1957, Anton Dohrn Bank, 6, 130—160 mm.,
4. 6. 1957, Anton Dohrn Bank, 4, 110—145 mm.,
2. 9. 1957, Anton Dohrn Bank, 3, abt. 140—160 mm.,
5. 10. 1957, Anton Dohrn Bank, 3, abt. 110—140 mm. standard length,
18. 10. 1957, Anton Dohrn Bank, 1, 143 mm.,
12. 11. 1957, Anton Dohrn Bank, 1, abt. 130 mm. (broken),
all from stomachs of *Gadus callarias*.

[1]) The specimens were tentatively determined as *atlanticus* without re-examination of the type. They are quite different from *B. benedicti* Goode & Bean in the fewer anal rays (12–14), the higher gill-raker counts (8–9 + 17–18), and the considerably higher counts of the tiny mandibular teeth (80 in each half of the jaw). The number of vertebrae was found to be 45–47. There is no earlier record of *Bathylagus* from East Greenland.

[1]) We found the specimen too badly mutilated to be absolutely sure of the identification. Unfortunately, the barbel was missing but, there was a fair degree of correspondence in the body proportions, the number and arrangement of the teeth and in the postocular organ. Only one atronesthid fish, *Astronesthes gemmifer* Goode & Bean, was recorded from West Iceland (RAE, 1951).

[2]) That myctophid was not present in the catches of the F.R.S. "Anton Dohrn" in 1955, when it was replaced by *Notoscopelus elongatus* (Costa), a species which was never found in 1957. The specimens were carefully compared and the earlier identifications verified.

Mallotus villosus (Müller 1776)

1. 5. 1957, Anton Dohrn Bank, 1, abt. 18 cm.,
18. 10. 1957, Anton Dohrn Bank, 1, 125 mm. standard length,
12. 11. 1957, Anton Dohrn Bank, 4, 142—153 mm. standard length,
all from stomachs of *Gadus callarias*.

Mora mora (Risso 1810)

1. 5. 1957, Anton Dohrn Bank, 1, 143 mm., from the stomach of *Gadus callarias*. First record from Greenland waters.

Notolepis rissoi krøyeri (Lütken 1892)

18. 8. 1957, Fiskenaes Bank, 6, abt. 23—26 cm., from the stomachs of *Gadus callarias*. Not represented in the list by KOTTHAUS & KREFFT, 1957.

Notosudis lepida Krefft & Maul 1955

4. 6. 1957, Anton Dohrn Bank, 1, abt. 22 cm. (tail broken off),
from the stomach of *Gadus callarias*. Second specimen from East Greenland.

Paralepis brevis Zugmayer 1911

2. 9. 1957, Anton Dohrn Bank, 1 (head only, 82 mm.),
from the stomach of *Gadus callarias*.

Paralepis cor. borealis Reinhardt 1838

18. 8. 1957, Fiskenaes Bank, 1, 251 mm. (and 1?, badly mutilated),
from the stomach of *Gadus callarias* (together with *Notolepis rissoi krøyeri*).

Searsia schnakenbecki Krefft 1953

15. 4. 1957, Anton Dohrn Bank, 2, 95 mm. standard length, and a broken specimen,
1. 5. 1957, Angmagssalik, 1, 124 mm.,
1. 5. 1957, Anton Dohrn Bank, 1, 103 mm.,
5. 10. 1957, Anton Dohrn Bank, 1, 164.8 mm. standard length, 46 vertebrae,
all from stomachs of *Gadus callarias*.

Serrivomer spec.

15. 4. 1957, Anton Dohrn Bank, 1, head only,
1. 5. 1957, Angmagssalik, 2, abt. 42 and 48 cm.
1. 5. 1957, Anton Dohrn Bank, 1, head only,
all from stomachs of *Gadus callarias*.

Stomias boa ferox Reinhardt 1842

5. 10. 1957, Anton Dohrn Bank, 2, abt. 25 and 29 cm.,
12. 11. 1957, Anton Dohrn Bank, 1, without head,
all from stomachs of *Gadus callarias*.

Xenodermichthys copei (Gill 1884)

1. 5. 1957, Angmagssalik, 1, 105 mm.,
1. 5. 1957, Anton Dohrn Bank, 1, 130 mm.,
both from stomachs of *Gadus callarias*. First record from Greenland waters.

G. KREFFT

B. Records of the Institut für Meeresforschung and the Abteilung Fischereibiologie der Biologischen Anstalt Helgoland, Bremerhaven

As in 1955 and 1956 the number of remarkable fish delivered by trawlers to our institutes in 1957, was very small. They were identified either by Dr. BRANDES (IFM) or Dr. KOTTHAUS (BAH).

Most of the fish listed below were caught by R/V "Anton Dohrn" in the waters between Iceland and Greenland in spring 1957 and identified by Dr. KOTTHAUS if not otherwise mentioned. In our list, we do not mention the species, which were found to be quite common in these areas and which were already recorded in the list given by KOTTHAUS & KREFFT, 1957.

The lengths are given as total length, if not otherwise stated and measured to the lowest cm. or mm. The station numbers of the "Anton Dohrn" catches are added in brackets after the position and depth.

Beryx decadactylus Cuv. & Val. 1829

17. 2. 1957, S.W. Iceland, 1, 39 cm. (caught by trawler), IFM.

Boreogadus saida (Lepechin 1773)

5. 4. 1957, 66°47'N.—27°08'W., 370 m. (AD 1612), 1, 19 cm.

Brama brama (Bonaterre 1789)

1. 9. 1957, S.W. Iceland, 3, 52—58 cm. (caught by trawler), IFM,
10. 9. 1957, 63°14'N.—24°50'W., 2, 55 and 58 cm. (caught by trawler), IFM,
14. 9. 1957, N.W. Iceland ("Gammelloch"), 2, 56 and 58 cm. (caught by trawler), BAH,
21. 10. 1957, S.W.coast of Norway, 1, 55 cm. (caught by trawler), IFM.

Careproctus gelatinosus (Pallas 1769)

5. 4. 1957, 66°47'N.—27°08'W., 370 m. (AD 1612), 4, 15—18 cm.,
6. 4. 1957, 65°45'N.—30°04'W., 395 m. (AD 1622), 3, 13—21 cm.

Centrolophus niger (Gmelin 1788)

20. 5. 1957, S.W. Iceland, 1, 1105 mm. (caught by trawler), BAH.

Derichthys serpentinus Gill 1887

14. 4. 1957, 65°26′N.—30°15′W., 475 m. (AD 1679), 1, 213 mm., broken.

New for the Iceland-Greenland Ridge.

Gaidropsarus argentatus (Reinhardt 1838)

5. 4. 1957, 66°47′N.—27°08′W., 370 m. (AD 1612), 3, 14, 16, and 22 cm.,
6. 4. 1957, 65°57′N.—28°54′W., 375 m. (AD 1617), 3, 16, 17, and 21 cm.,
13. 4. 1957, 66°12′N.—27°25′W., 430 m. (AD 1676), 2, 19 and 31 cm.,
20. 4. 1957, 63°03′N.—23°57′W., 450 m. (AD 1724), 6, 20—29 cm.

Gymnelis viridis (Fabricius 1780)

6. 4. 1957, 65°57′N.—28°54′W., 375 m. (AD 1617), 2, 141 and 116 mm.

Lepidion eques (Günther 1887)

15. 4. 1957, 64°59′N.—34°28′W., 470 m. (AD 1686), 2, 175 and 216 mm.,
20. 4. 1957, 63°03′N.—23°57′W., 450 m. (AD 1724), 6, 20—29 cm.

Lycodes esmarkii Collett 1874

5. 4. 1957, 66°28′N.—25°32′W., 436 m. (AD 1607), 1 ♂, 49 cm.,
5. 4. 1957, 66°47′N.—27°08′W., 370 m. (AD 1612), 1, 14 cm.,
6. 4. 1957, 65°57′N.—28°54′W., 375 m. (AD 1617), 2, 38 and 47 cm.,
13. 4. 1957, 66°12′N.—27°25′W., 430 m. (AD 1676), 1, 37 cm.

Lycodes eudipleurostictus Jensen 1901 (determined by Dr. Krefft)

1. 4. 1957, 67°11′N.—23°04′W., 288 m. (AD 1591), 1 ♀, 230 mm.,
2. 4. 1957, 67°28′N.—23°30′W., 506 m. (AD 1592), 4 ,204, 283, 333, and 381 mm.

Malacosteus niger Ayres 1857

14. 4. 1957, 65°53′N.—28°45′W., 430 m. (AD 1678), 1, 160 mm. standard length,

from the stomach of *Gadus callarias*

12. 11. 1957, 65°30′N.—31°15′W., 1, 24 cm. (caught by trawler), IFM.

New for the Iceland-Greenland Ridge.

Triglops pingeli pietschmanni Jensen 1944

6. 4. 1957, 65°57′N.—28°54′W., 375 m. (AD 1617), 36, 12—18 cm.

C.-H. Brandes, A. Kotthaus

Scotland

Somniosus microcephalus (Schneider)—female, 4.35 cm., Faroe, 9. 9. 57.

Diplolychnis bifilis Regan & Trewavas—
61°51′N.—23°25′W., 9. 4. 57.

Trachyrhynchus murrayi Gunther—
62°45′N.—22°04′W., 8. 4. 57.

Antimora viola (Goode & Bean)—
62°28′N.—14°23′W., 6. 4. 57.

Brama raii (Bloch)—

2 fish, Geo. Bligh Bank, July 1957.
3 fish, Lousy Bank, August 1957.
1 fish, Faroe Bank, September 1957.

Aphanopus carbo Lowe—

3 fish, Geo. Bligh Bank, July 1957.

Mola mola L.—1 fish, Lousy Bank, August 1957.

The records of the last three species have also been included with those of the Near Northern Seas.

B. B. Rae, J. M. Lamont

Near Northern Seas

INTRODUCTION

Contributions to this report have been received from: –

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A. Environment

Extensive hydrographic information has been provided by the Danish research vessels "Dana" and "Jens Væver". Water temperatures in the bottom layers of the North Sea were 1—2°C. higher in the spring of 1957 than in 1956, except in the southernmost part. In autumn too, the water temperatures near the bottom were nearly everywhere some 1°C. higher than in 1956. The salinity pattern was very similar to that recorded for 1956, with the exception of the Dogger Bank area, where higher values were observed, both in spring and autumn, as compared with 1956.

In contrast to the situation the year before, the influence of the Baltic was now greater in spring than in autumn, whereas the Bløden Ground waters showed normal features in 1957.

Scottish hydrographical observations reveal also a high degree of activity. Both dynamic assessment from the temperature and salinity distribution, and the interpretatior of drift-bottle returns indicate that the exceptionally strong Atlantic Current of November 1956 receded slowly in intensity during January and February 1957, and probably more rapidly in March, April, and May, but resuscitated to an abnormally high—but temporary—maximum intensity in June 1957, to recede once more until late autumn, when it built up again more gradually to the usual high early winter intensity characteristic of the Atlantic Current in the Faroe-Shetland area.

The cyclonic winds of the winter 1956—1957 produced an exceptionally large invasion of oceanic water. In the coastal region the high rainfall of the latter half of the year produced a noticeable reduction of the salinities. That the water circulation increased again in mid-summer, as indicated by drift-bottle observations, is illustrated by the rate of flow of 10 to 20 km. per day in August and September, as compared with 1 and 2 km. per day in June.

The "Anton Dohrn" worked 153 stations in the Skagerak and adjacent North Sea in mid-winter. The cyclonic motion did not reach deeper than some 200 metres. In deeper layers the oceanic water spread into the Norwegian Rinne from west to east. The upwelling of relatively warm water in the centre of the cyclonic circle, so characteristic for mid-winter conditions, could be demonstrated. The cold and brackish Baltic water flowed out along the surface through the central and northern part of the Skagerak, while oceanic water flowed in along the bottom.

Observations made from German lightships demonstrate that the 1957 surface temperatures in the German Bight were higher in February to April inclusive, and lower in September, as compared with the period 1950—1954, and that surface salinities were rather low throughout the year in this area.

The "Anton Dohrn" collected hydrographical data in the Dogger Bank area in September. Bottom water of a temperature below $7^1/_2$°C. was found at the northern edge of Dogger Bank, and a small area of cold bottom water (below 10°C.) was observed at the south-eastern edge. At a depth of 43 m. a clear-cut thermocline at the northern edge was observed, but the Dogger Bank itself appeared to be covered by water of a fairly homogeneous character at that time of the year.

According to Danish observations the temperature anomalies of the surface waters off the eastern coast of Scotland were positive in 1957, with exception of September. For the entire year the anomaly has been computed as 0.6°C., a substantially higher figure than the 0.1°C. for the year 1956.

Two years of Scottish thermograph recording, made at 3 m. depth in the North Minch, have been illustrated in diagrams.

Of the greatest interest for the study of the dispersal of herring larvae are the conclusions based on drift-bottle and drift indicator observations made in the Firth of Clyde. Although observations on surface movements only make it difficult to reach a decisive conclusion on the dispersal of herring larvae, it is interesting to note that the larvae would have been carried into the Firth according to the first set of observations, and out of it according to observations made some 20 days later.

Danish and Swedish observations in the Kattegat reveal that the deviations from the normal pattern of salinity and temperature were rather slight. Surface salinities were rather high in the months of May and October; bottom salinities appeared to be slightly above normal in the Danish waters throughout the year. Water temperatures exceeded the normal level in most of the months of the year 1957.

Scottish plankton investigations revealed that the spring diatom peak in the northern North Sea equalled the very high figures recorded for May 1956, and that diatoms were also unusually abundant in late summer and autumn. Estimation of faecal pellets, instituted in 1957, showed a peak value in June, coinciding with high copepod figures. Detailed information is presented on the whereabouts of temporary concentrations of a number of plankton organisms.

Zooplankton was rather scarce in the northern North Sea early in the year, but increased in numbers late in spring, so that by June *Calanus* and other copepods were very abundant over almost the whole area north of 57°N.L. Their number decreased late in summer, but one observed a peak of minor importance in November. Plankton evidence suggests only a slight influx into the North Sea via the north of Shetland in 1957.

The Continuous Plankton Recorder survey has been extended in recent years. A rough estimation of distribution and abundance of phytoplankton suggests that it was rather less abundant than in previous years around the British Isles, and that the spring outburst was earlier in the North Sea than that over the deep Atlantic. The numbers of *Calanus finmarchicus* were low in the Atlantic, but in the North Sea their number was appreciably higher than in the lean years 1954 and 1955, be it still below the figures recorded in the period 1950—1953.

Observations on "indicator" species indicate that the plankton around the British Isles in 1957 was, in most respects, similar to that of 1956, and suggest that there may not have been such a strong oceanic influx into the North Sea as in the summers of 1952, 1953, and 1954.

Continuation of the collection of data on dry weight of Hensen-net plankton on and north of the Flamborough Line revealed high values for 1955 and 1957 north of the Line, in comparison with the years 1957—1951, whereas the figures for 1956 came closer to the level observed in this earlier period. On the Flamborough Line itself the dry weights in recent years did not differ appreciably from the average for the entire period 1947—1951.

Quantitative investigations on bottom invertebrates in the German Bight have been continued. The severe winter of 1955/56 exerted a considerable influence in the shallower waters. Many species suffered heavy losses there, which interrupted the gradual increase in density of lamellibranchs and polychaetes observed since the spring of 1954. The mild winter 1956/57, on the other hand, spared the lives of countless invertebrates, so that the stock of fish food was unusually abundant in the autumn of 1957. The excellent plaice food *Angulus fabula* was in 1957 even more abundant than in the favourable year 1955, and extraordinary high figures were found for *Montacuta bidentata*. Winter mortality has also been measured by counting the numbers of double lamellibranch valves per 0.1 m^2., which corroborated that far lower losses were suffered in the winter 1956/57 than in the preceding cold winter. The polychaetes *Spiophanes bombyx* and *Pectinaria koreni* appeared to be very abundant in autumn 1957. The number of crustaceans appeared to vary very little from year to year; the echinoderms, on the other hand, appeared to be very sensitive to severe winters.

B. The Fish

The German plaice investigations in the south-eastern part of the North Sea were continued and intensified. During the cruises of the research vessels the work covered studies on age composition, growth, stock density, and comparative fishing. The age composition in the German Bight differed noticeably from that in 1956; as much as a quarter of the stock consisted of age-group I. Outside the German Bight age-group IV preponderated, forming 42% of the stock, which tallies with the high figures for age-group III in 1956. That growth was still better than in the year before is ascribed to a further decline in stock density. Migration to deeper water strongly affects the stock density of the larger plaice.

Hauls made at different hours of day and night yielded remarkable figures; the best catches were made in the middle of the day and at about midnight.

Market investigations revealed that the 1952 year-class dominated in the 1956 cutter landings, be it that the 1953 plaice prevailed slightly in the latter part of the year, and again in the first part of 1957. In its turn year-class 1954 came to the fore late in 1957. Among the older fish the 1947 year-class was still prominent.

Danish investigations revealed an unusual abundance of small plaice off Esbjerg. The 1952 year-class dominated in the marketable plaice in the years 1955 and 1956, but had disappeared in 1957. Market investigations (Esbjerg) gave an insight into weight distribution and mean weight of plaice from various grounds in the North Sea.

Transplantation of plaice from the Nissum Broad to the inner broads of the Limfjord has been continued. Length and weight of the transplanted plaice appeared to be smaller than in the preceding 4 years, despite the fact that age-group III was represented with 33%. Tagging was continued, to facilitate quantitative conclusions on the results of transplantation.

Danish inshore observations revealed an unusually high density of 0-group plaice at the northern part of Jutland's North Sea coast. Also in the Kattegat this group occurred in large numbers. The figures for flounder show a low density of 0-group specimens at the Danish coasts. The 0-group sole appeared to be rich at the coast of Seeland.

That the plaice in the commercial catches taken north and south of the Scaw appeared to be smaller than a year before is explained in terms of richer and poorer year-classes. The same type of arguments has been used to explain the large size of the plaice caught in the Aalborg shallows.

In view of the *Fish Stock Record* and the *Statistical News Letter* the usual information on English landings of plaice, sole, and whiting will no longer be published in the *Annales Biologiques*, to avoid unnecessary duplication.

Vertebrae counts made on whiting landed at IJmuiden indicate that it is possible to distinguish between a northerly and a southerly whiting population in the North Sea.

German sand-eel landings show a mushroom development of the sand-eel industry. The catches amounted to 25,500 tons in 1957. The by-catches are almost insignificant. The overwhelming majority of the sand-eel caught appeared to belong to the subspecies *Ammodytes lancea marinus*. The fat content in the sand-eels fluctuated between 6 and 7% from April to July. The male gonads are rich in fat and poor in ash, whereas the reverse holds good for the female gonads.

Neither the sand-eel fishery nor the fishing of young herring for processing led to a significant destruction of undersized protected food fish. The percentage of undersized fish of other species varies with the abundance of their respective year-classes. The variation in year-class strength also affects the ratio of undersized specimens to the total catches of the species concerned.

Quantities of various species of fish caught by the German shrimpers, also expressed as percentages of the total catch, are presented. The percentage figures are of a rather reassuring character, but some doubt may remain on the effect of the total quantities of undersized protected fish landed by the shrimpers.

A number of rare fishes encountered in the Near Northern Seas area is listed.

P. Korringa

ENVIRONMENT

Hydrography

Hydrographic Conditions in the North Sea 1957

(Figures 1–14)

The R/V "Dana" has worked in the North Sea in April—May and August—September. Furthermore M/C "Jens Væver" made a hydrographical survey of the northern Bløden Ground in July as a prelude to the ICES herring tagging experiment. Figures 1—14 show the distribution of temperature and salinity.

The bottom temperatures in April—May 1957 were 1°—2°C. higher than the bottom temperatures in April—May 1956 in most of the North Sea. Near the Channel, however, the bottom temperature was nearly the same in April—May in the two years. The salinity distribution at the bottom was very much the same in April—May in the two years, but on and north of the Dogger Bank somewhat higher salinities were found in 1957.

The bottom temperatures were still high in August—September 1957 as compared with 1956, viz. about 1° higher except on the Dogger Bank and the east coast of Scotland, where the conditions were very similar in the two years. As regards salinity the autumn conditions were very alike in the two years, but, just as in spring, higher salinities were found in 1957 on and north of the Dogger Bank.

The sections indicate that the Baltic influence was greater in spring than in autumn 1957, opposite to the situation in 1956.

The development on the Bløden Ground was almost normal in 1957, quite opposite to the situation in 1956, when the mixing of the water masses took place about one month earlier than normally.

KNUD P. ANDERSEN

Figure 1. Bottom temperature, 5/4—23/5 1957.

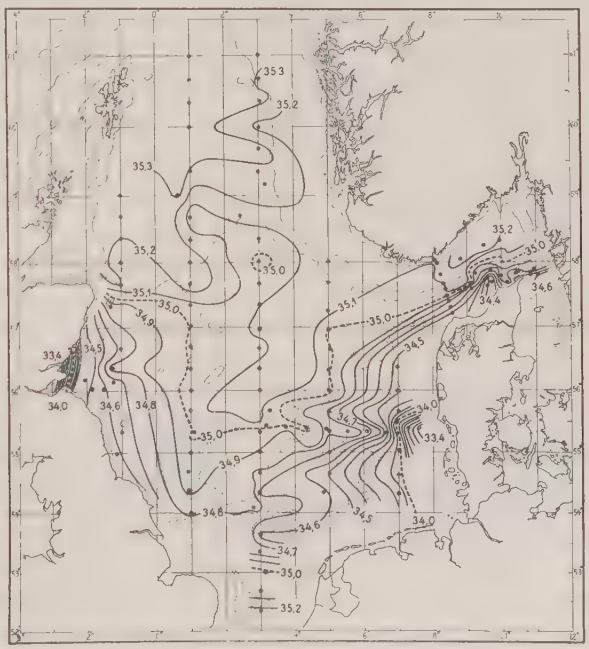


Figure 2. Bottom salinity, 5/4—23/5 1957.

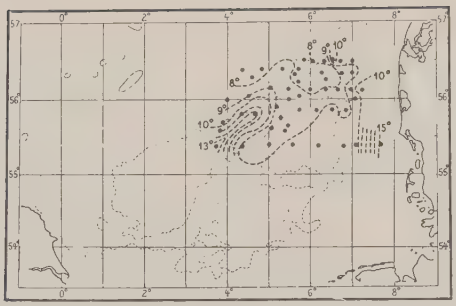


Figure 3. Bottom temperature, 16/7—22/7 1957.

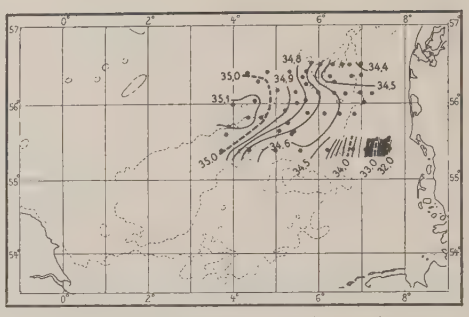


Figure 4. Bottom salinity, 16/7—22/7 1957.

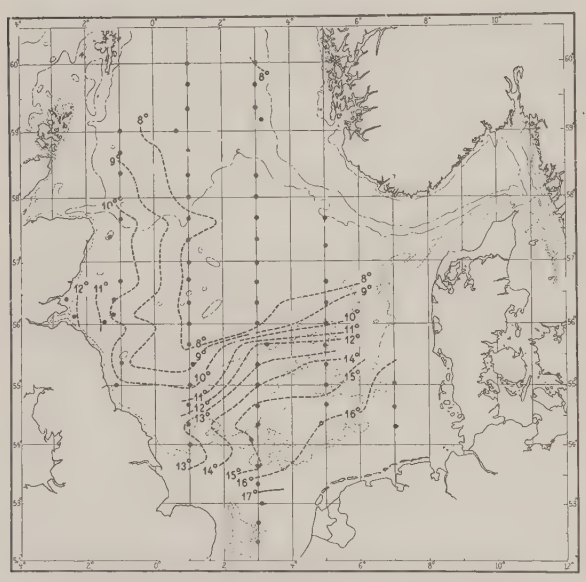


Figure 5. Bottom temperature, 21/8—28/9 1957.

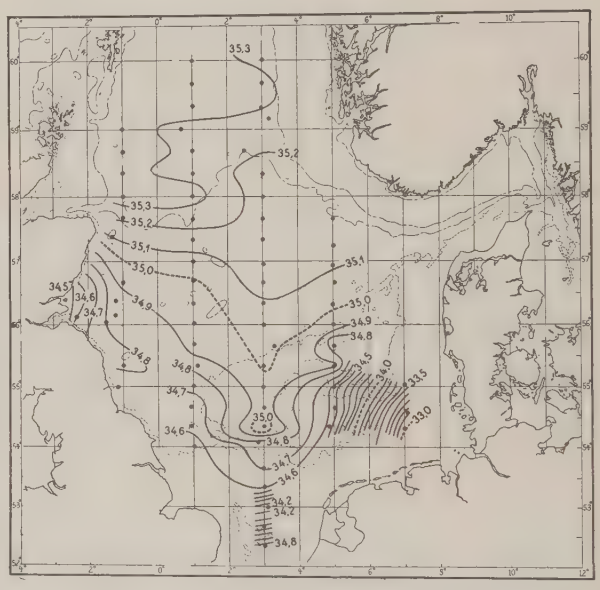


Figure 6. Bottom salinity, 21/8—28/9 1957.

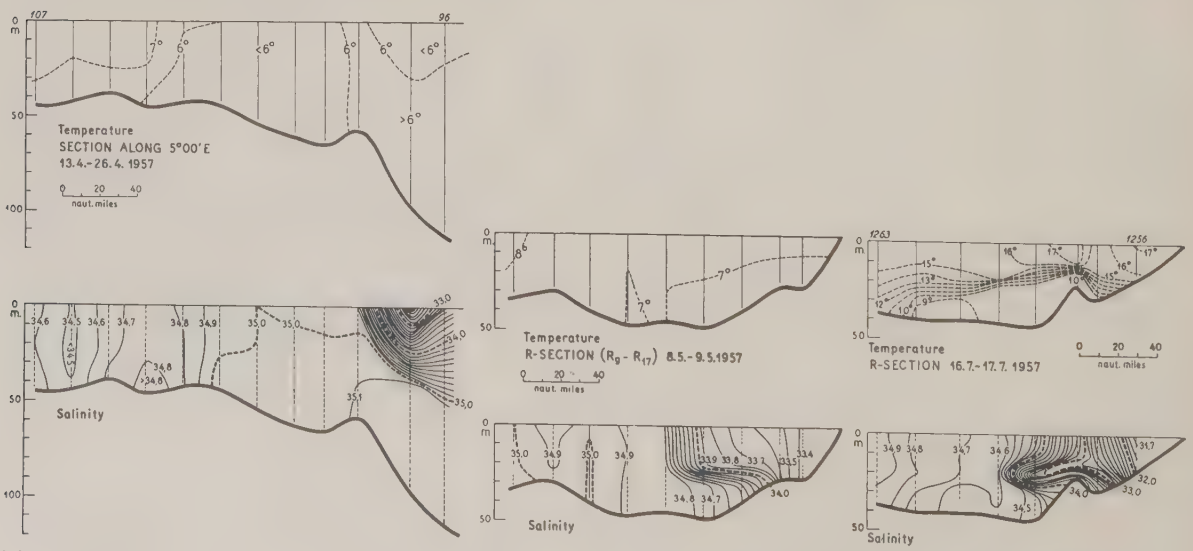


Figure 9. Section along 5°00'E., 13/4—26/4 1957. Figure 10. R-Section, 8/5—9/5 1957. Figure 11. R-Section 16/7—17/7 1957.

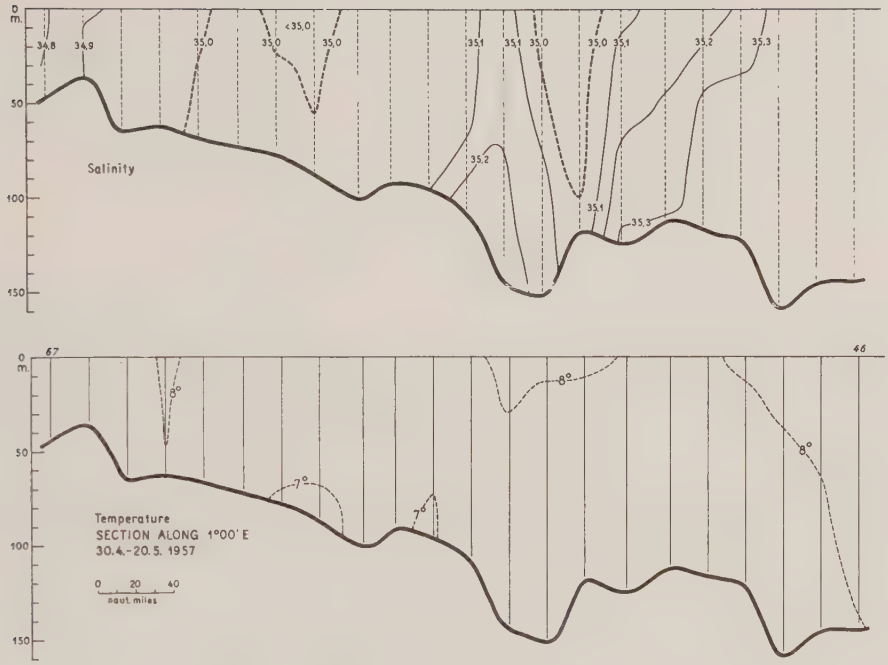


Figure 7. Section along 1°00'E., 30/4—20/5 1957.

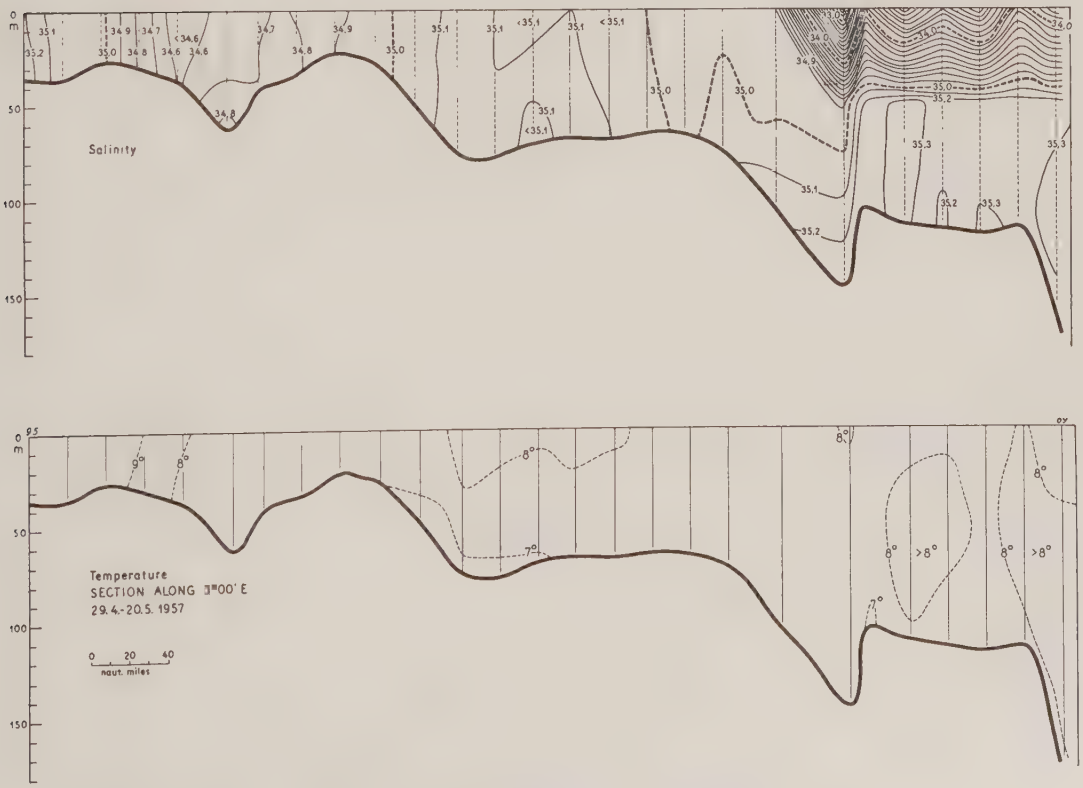


Figure 8. Section along 3°00'E., 29/4—20/5 1957.

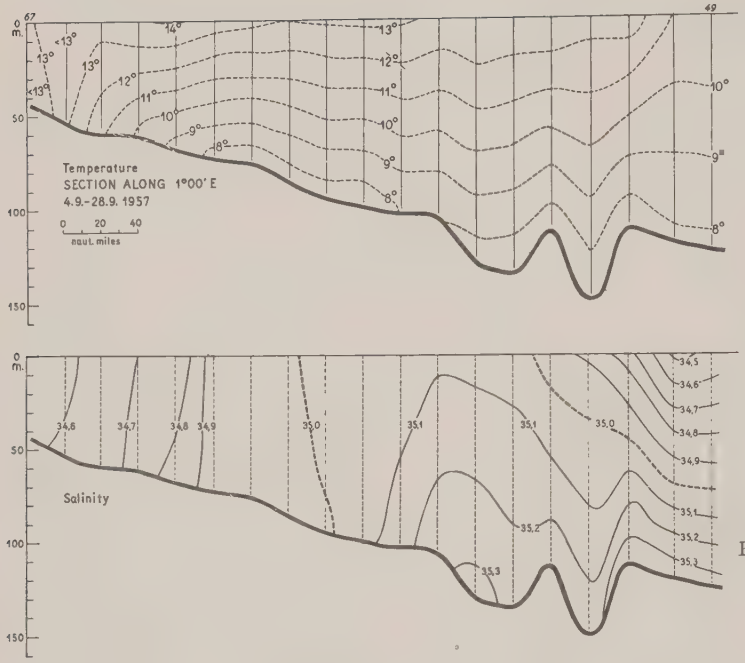


Figure 12. Section along 1°00'E., 4/9—28/9 1957

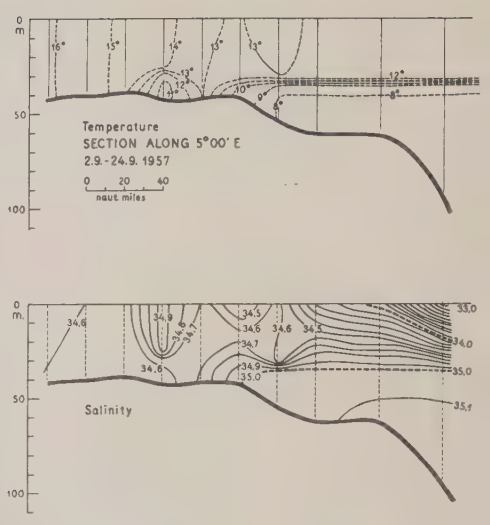


Figure 14. Section along 5°00'E., 2/9—24/9 1957.

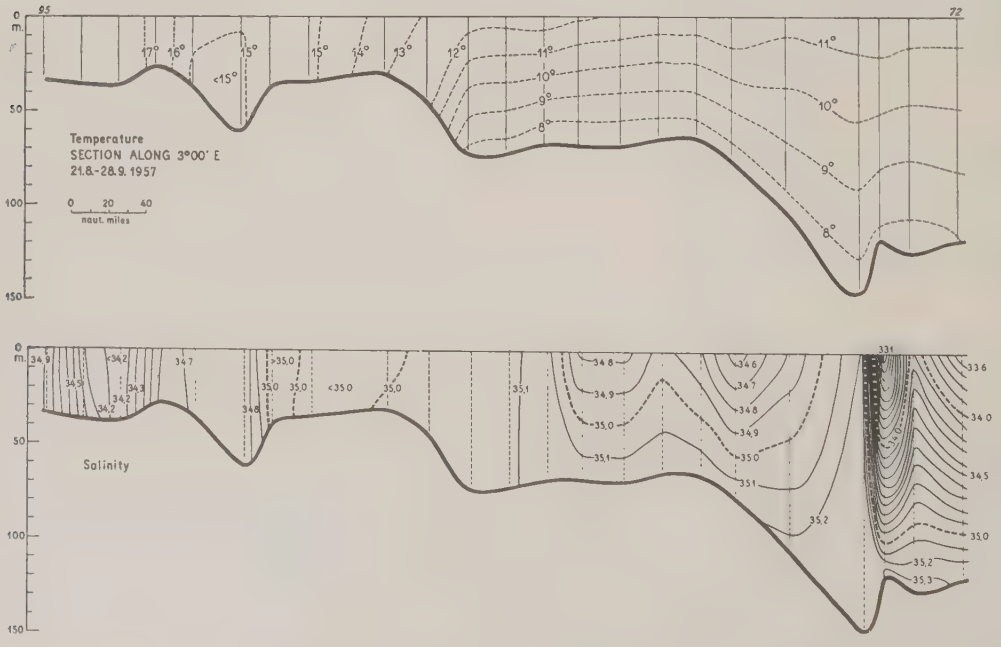


Figure 13. Section along 3°00'E., 21/8—28/9 1957.

Table 1. Scottish hydrographic observations, 1957

Vessel	Hydrographic stations	Temperature observations	Salinity observations	Oxygen observations	Phosphate Free	Phosphate Total	Drift-bottles Liberations	Drift-bottles Recoveries
"Scotia"	576	2,670	2,534	370	977	11	1,117	245
"Explorer"	410	2,874	2,834	625	1,226	18		
"Clupea"	316	1,527	1,515	—	422	—	445	196
"Kathleen"	60	120	120	111	108	—	—	—
Weather Ships ..	—	—	—	—	—	—	725	63
	1,362	7,191	7,003	1,106	2,733	29	2,287	504

Near Northern Seas and Approaches

(Tables 1–2)

With more frequent visits throughout the year than hitherto to the waters round Iceland, but embracing also the northern and central North Sea, Faroe-Shetland Channel, and west Scottish regions, the Scottish research ships in 1957 recorded hydrographic observations as enumerated in Table 1 which also contains summary indication of the scope of surface drift-bottle liberations by Weather Ships.

Dynamic assessment from the relevant temperature and salinity distributions showed a marked recession in February 1957 in the strength of the Atlantic Current through the Faroe-Shetland Channel from the extraordinary high value of over 20 km.^{3}/hr. which apparently characterized the Current in November 1956 and which was reminiscent of December 1951. In the month of June 1957, a similar very high transport value was again calculated, with the difference, however, that the major part of the Current then flowed northwards to the west of Faroe Bank and the Faroe Islands and not through the Faroe-Shetland Channel. A similar state was recorded in May—June 1951.

By September 1957 the dynamic indication is that the Atlantic Current had again receded to more normal intensity from its very high summer transport towards the Norwegian Sea.

The total surface drift-bottle return to date from the 1957 liberations, as can be seen from Table 1, represents a recovery of 22% of the number of bottles put out. Excluding, however, those liberations made by the research vessel "Clupea" in large quantity in estuarine waters, the truer return for comparison with previous years' results is 17%, a ratio which is still substantially in excess of corresponding returns for immediately previous years.

Breaking these figures down into components of regions of liberation and recovery, Table 2 elicits further information as to the broad features of the surface circulation of the regions concerned in 1957. Liberations and results from "Clupea" are omitted from this table.

In the light of a French coast recovery from liberations at the position 56°50'N., 12°00'W. *en route* to Weather Station "I", the absence of any such record from the Weather Station "J" liberations is perhaps remarkable. Such returns from Weather Station "K" in latitude 45°N. longitude 16°W., as were in fact recorded, are but to be expected.

It is noteworthy that Station "I" liberations, among others more usual from this position, resulted in recoveries on Skagerak and North Sea Norwegian coasts, all three in the last quarter of the year.

Faroe-Shetland liberations in February, June, and September also yielded similar returns in December 1957, besides the expected crop of recoveries on the Norwegian coast beyond the North Sea, the latter embracing the months of

Table 2. Drift-bottles at Weather Stations "J" (A), "I" (B), "A" (C) and "K" (D), in the Faroe-Shetland Channel (E) and the North Sea (F)

	Liberations No. of drifters	Recoveries Frequency-distribution[1]) o'	0	1	2	3	4	5	9	10	11	12	13	14	15	16	17	Total
A	200	—	13	4	1	—	—	—	—	—	—	—	—	—	—	—	—	18
B	435	1	5	16	5	4	—	—	—	—	1	2	6	—	1	1	1	43
C	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
D	80	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
E	285	—	—	—	13	2	—	—	—	—	3	2	20	—	—	3	—	43
F	832	—	—	—	1	2	1	1	4	20	92	26	52	2	1	—	—	202

[1]) For definition of column numbers see footnote p. 94 of Ann. Biol., **8** (1951).

June, September, and October, each singularly, and November and December in marked concentration.

Skagerak recoveries accounted for 45% of the returns from North Sea liberations in practically all months from March to November inclusive and the frequency distribution of these shows a preponderance of recoveries effected in the last quarter of the year, particularly in October—November, falling off sharply after the end of the year and rising equally abruptly after a nil return in August. A significant number of Skagerak recoveries took place in July 1957 and in conjunction with this it is noteworthy that two recoveries from open sea liberations were effected also in July on the Scottish east coast farther south than it has been usual to find them for many years. Further contemporary returns, were recorded from the west Danish coast south of the Skagerak entrance and also from the North Sea Norwegian coast, an initial return from the latter occurring in June 1957. Thereafter, there was a complete blank in all of these eastern North Sea extra-Skagerak recoveries until October when 90% of all the west Danish coast recoveries were effected and about 25% of those on the North Sea Norwegian coast, the bulk of the latter occurring in November-December and tailing off in January 1958.

The interpretation of these various dynamic and drift-bottle current indications is that the exceptionally strong Atlantic Current of November 1956 receded slowly in intensity during January and February 1957 and probably more rapidly in March, April, and into May, but resuscitated to an abnormally high but temporary maximum intensity in June 1957, to recede once more until the late autumn when it built up again more gradually to the high early winter intensity which seems to have been characteristic of the Current in the Faroe-Shetland Channel in this season for the past ten years at least.

J. B. Tait

Hydrographic Surveys of the Northern North Sea, 1957

(Figures 15–17)

In marked contrast to the two preceding years, 1957 shows the northern North Sea strongly influenced by oceanic water. Salinities have been high throughout the year except in coastal regions which have been affected by the high rainfall of the latter half of the year. Temperatures everywhere were well above average in March, and this is reflected in the high temperature later of the central core of water below the thermocline. Surface temperatures, however, rose little after early July and the July to September surface temperatures were below recent experience. These statements are illustrated by Figures 15, 16, and 17.

To analyse the year more closely it seems that the cyclonic winds of the winter gave an exceptionally large invasion of oceanic water up to the end of February which may be wholly unprecedented. In March to June there was a period of quiescence corresponding to the dry anticyclonic winds. In this period mixing reduced the salinity of the oceanic water somewhat. Evidence of drift indicators suggests that from July to September the rate of circulation increased again to high values. Rates of flow of 20 km. per day at 10 metres depth and 12 km. per day at 80 metres depth were indicated during August—September, compared with 1 to 2 km. per day in June.

R. E. Craig

Figure 15. Temperature and salinity (expressed as D.C.I.) in the northern North Sea, 7.—28. March 1957. There was a gap in observations along latitude 58°N. and it was not felt possible to interpolate D.C.I. values accurately enough to be useful.

Figure 16. Temperature and D.C.I. values for the northern North Sea. The greater part of the area was surveyed in the period 31. May to 13. June. The south-western part was surveyed during the period 10. to 20. June. In the case of surface temperature the two parts are shown separately. In the other charts the fit is good enough to show the results as if they were simultaneous.

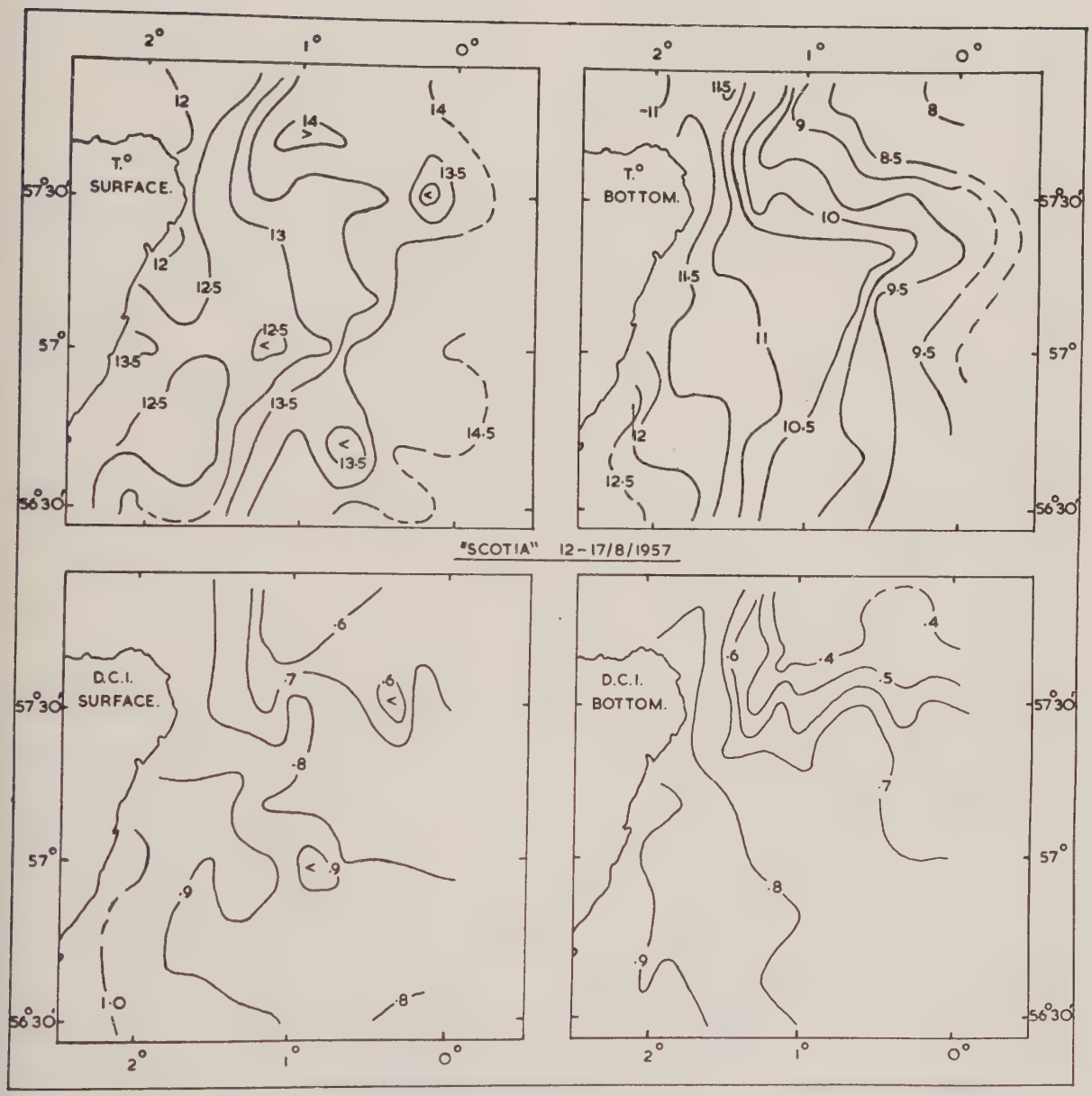


Figure 17. Temperature and D.C.I. values in a restricted region off the Aberdeenshire coast, 12. to 17. August 1957.

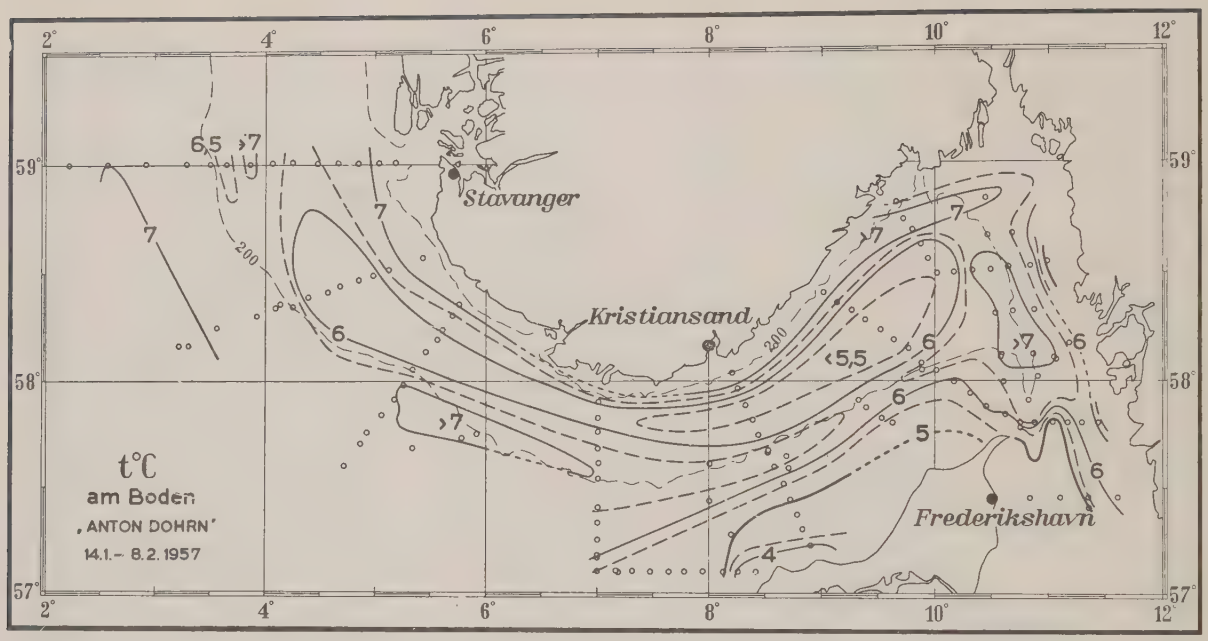


Figure 18. Bottom temperature in the Skagerak in winter 1957 based on a cruise with R/V "Anton Dohrn".

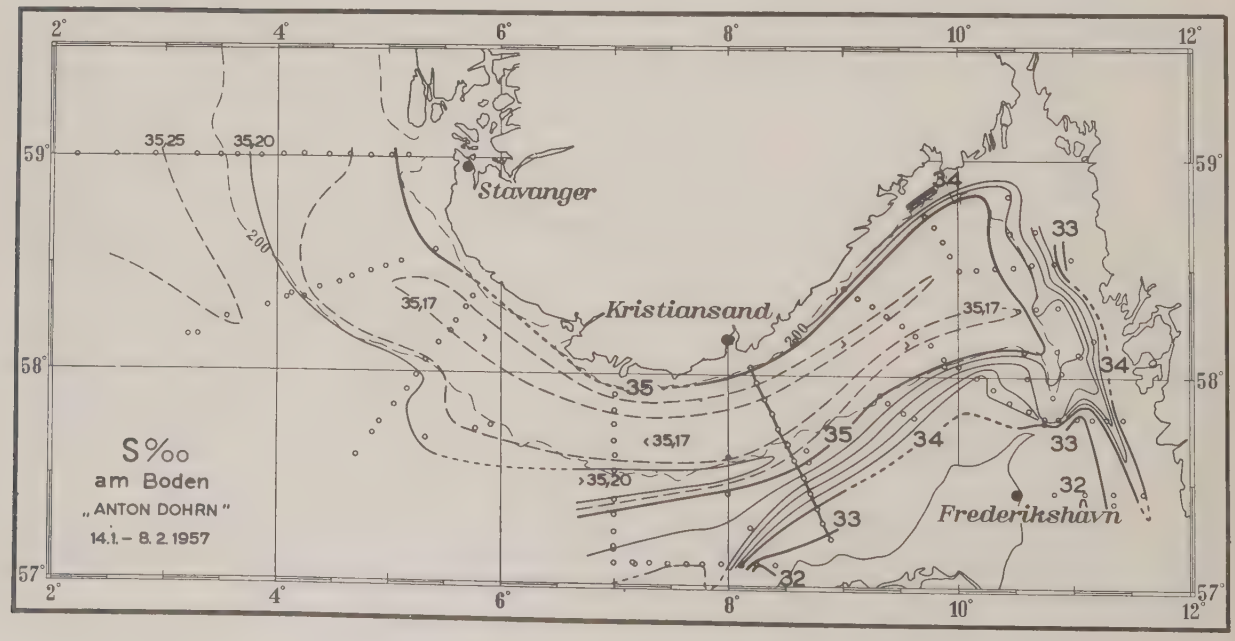


Figure 19. Bottom salinity in the Skagerak in winter 1957 based on a cruise with R/V "Anton Dohrn". The broken line shows the course of the section illustrated in Figures 20 and 21.

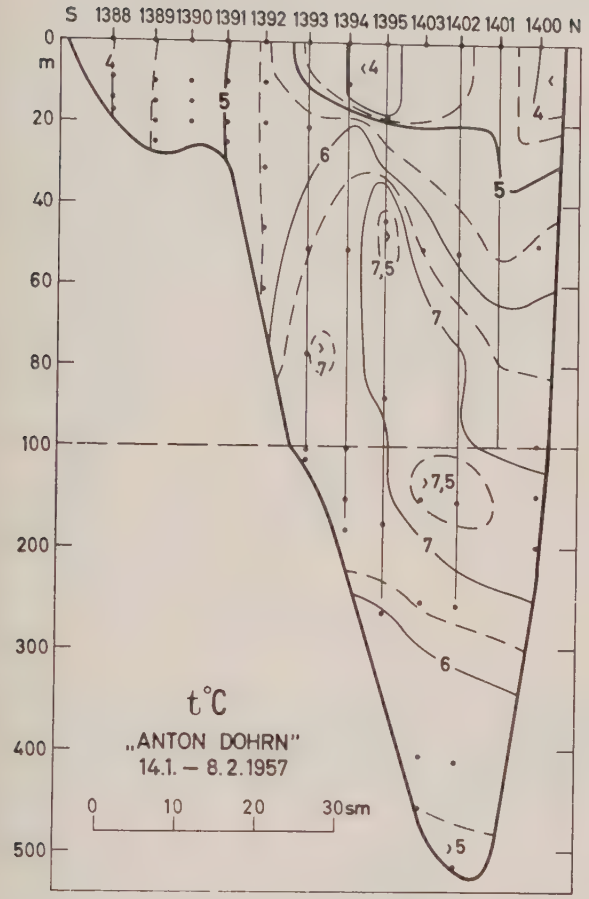


Figure 20. South-north temperature section across the Skagerak in winter 1957. The course of the section is shown in Figure 19. Vertical lines indicate where the bathythermographs were used.

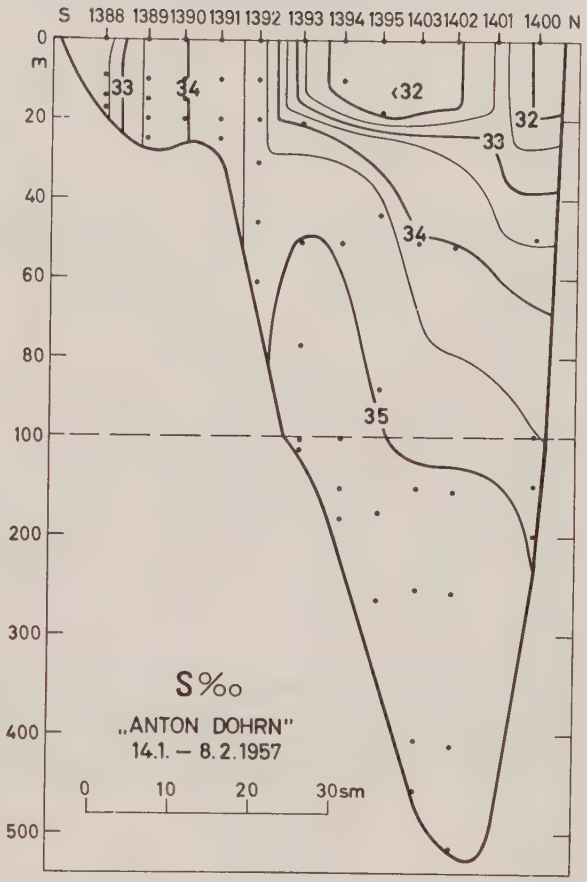


Figure 21. South-north salinity section across the Skagerak in winter 1957. The course of the section is shown in Figure 19.

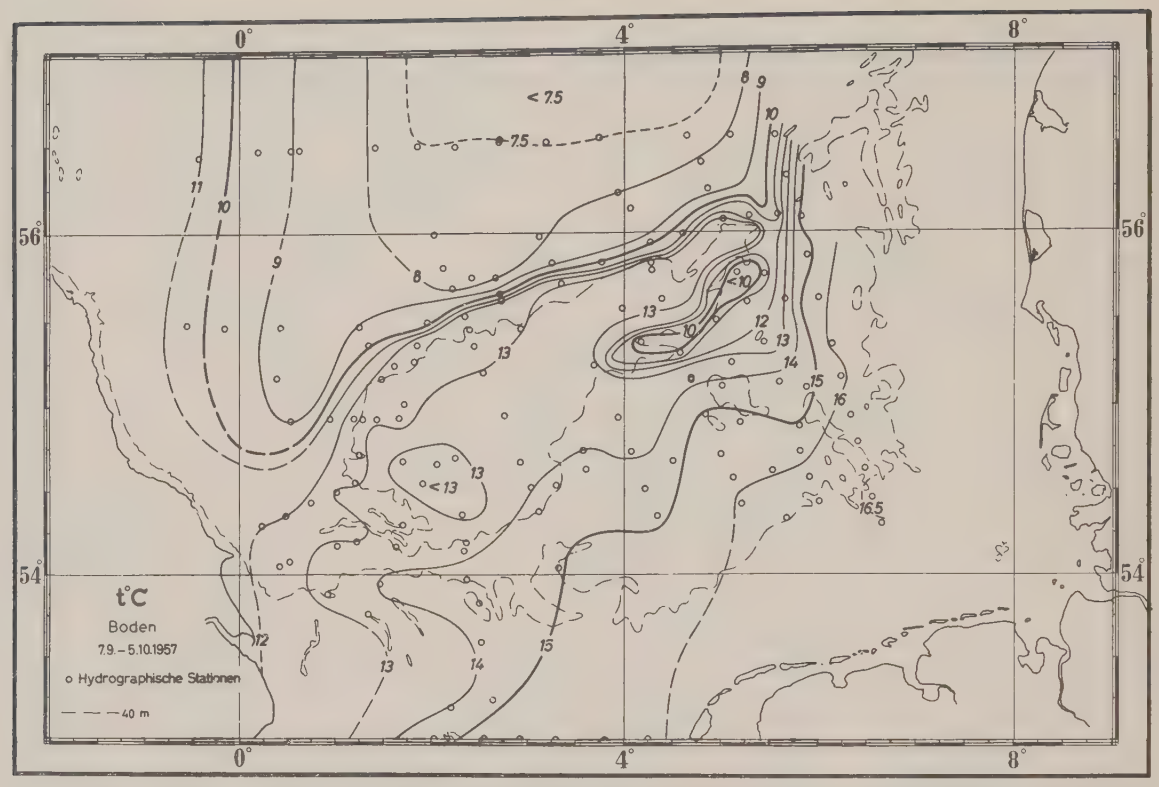
Hydrographic Conditions in the Skagerak and Northern North Sea in January/February 1957

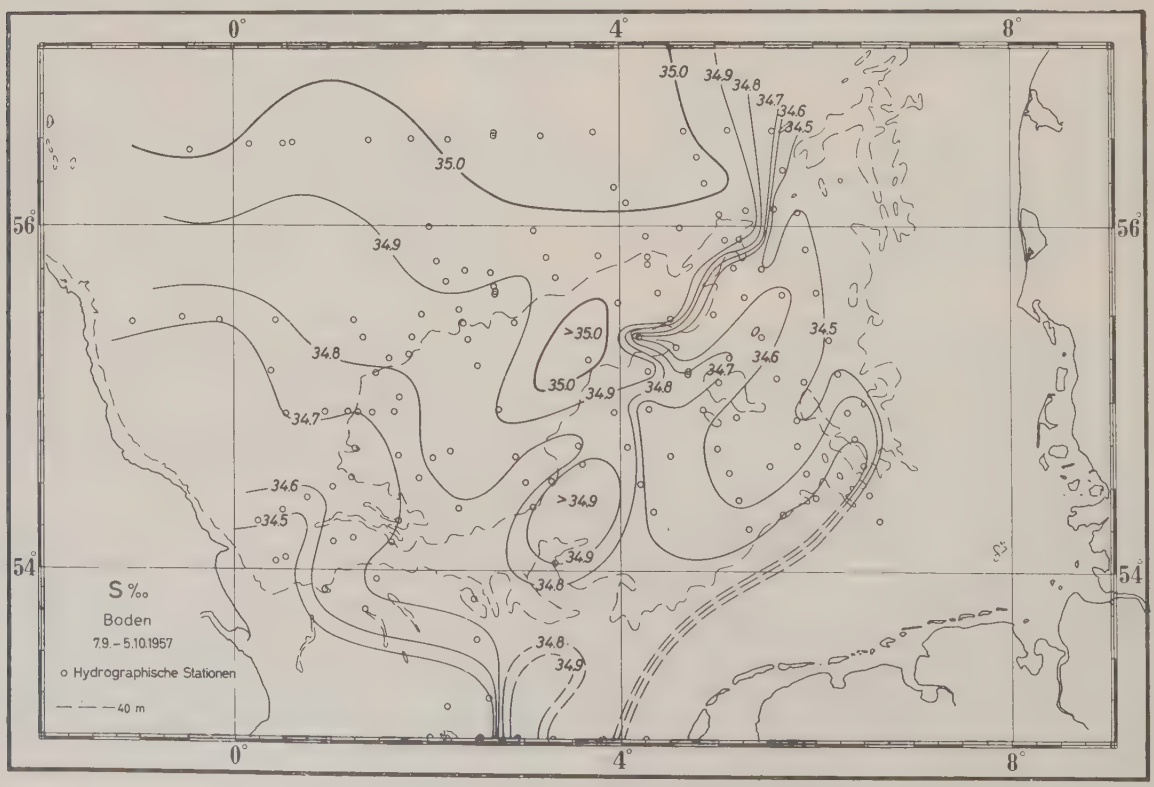
(Figures 18–21)

During a cruise in the Skagerak and in the northern North Sea from 14. January to 8. February 1957 the R/V "Anton Dohrn" worked 153 hydrographical stations. Their positions are shown in Figure 18. There are 115 stations in the Skagerak and Kattegat, and 43 stations in the North Sea crossing the Norwegian Rinne. At 86 stations bathythermographs were also used. At all the stations measurements near the bottom were carried out. Figures 18 and 19 show the bottom distribution of temperature and salinity. Figures 20 and 21 show temperature and salinity in a section running from Denmark to Christiansand in Norway in a south-east—north-west direction. The course is given in Figure 19.

The vertical scale in Figures 20 and 21 is divided into two parts by a broken line in a depth of 100 metres. Above 100 m. the scale is four times larger than below.

In Figures 18 and 19 the isolines are nearly parallel to the bottom isohypses from 0 to 200 metres. The cyclonic motion (counter-clockwise) does not reach deeper than about 200 metres and one can use in approximation the isolines as streamlines. The figures show the spread of oceanic water in the Norwegian Rinne from west to east below the 200 m. contour. In the Kattegat the heavier Skagerak water flows along the bottom into the Baltic Sea.





Figures 22 and 23. Bottom temperature and salinity in the Dogger Bank region in September 1957.

The temperature in the section (Fig. 20) shows the characteristic upwelling of warm water masses in the centre of the cyclonic circle in the Skagerak (during winter). Temperature and salinity in the section (Fig. 21) show that the homogeneous water masses are an effect of very strong mixing and cooling in the coastal parts. In the central and northern part of both sections the Baltic outflow, which is very cold and low in salinity may be observed in the surface layer. In Figure 21 the cyclonic circle is shown by the relatively high salinity in the southern part of the section (influx of North Sea water) and the relatively low salinity in the northern part (outflow of Skagerak water). Along the bottom, inflow of oceanic water is observed.

G. KOOPMANN

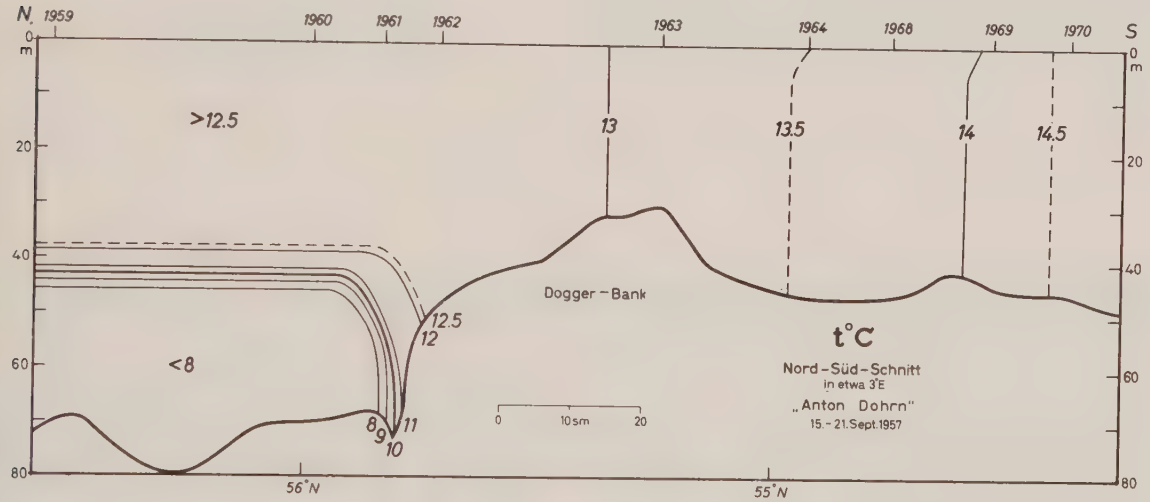
Hydrographic Conditions in the Dogger Bank Region

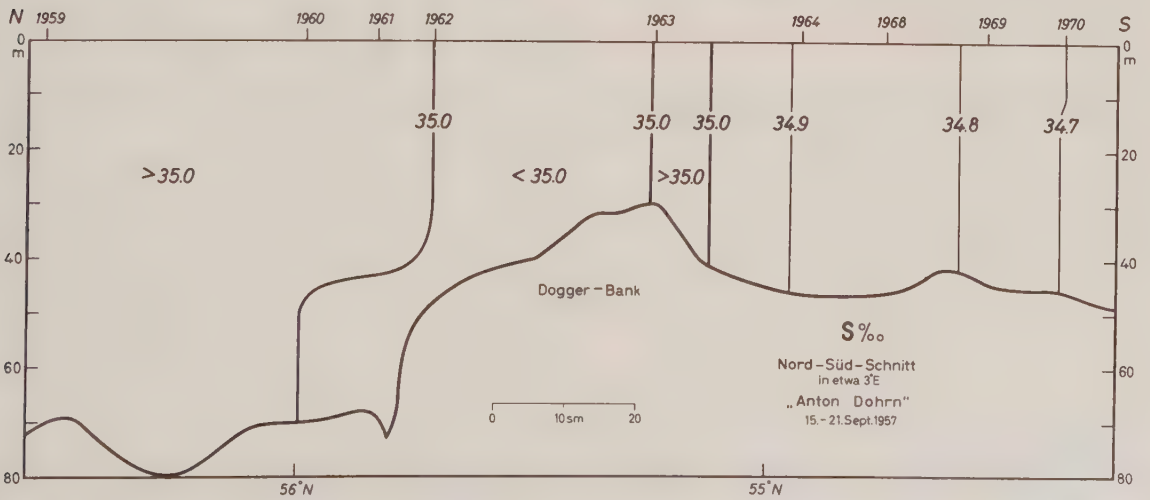
(Figures 22–25)

The research vessel "Anton Dohrn" worked 157 hydrographical stations in the central and southern North Sea in September and October 1957. The hydrographical results are shown in four diagrams.

Figures 22 and 23 show the distribution of temperature and salinity near the bottom. Figures 24 and 25 show the stratification of the water masses in a section across the Dogger Bank. The section was run between 56°31′N., 2°40′E. and 54°21′N., 4°19′E.

To the north of the bank the temperature of the bottom water was < 7.5°C. and the salinity $> 35\,^0/_{00}$.





Figures 24 and 25. Temperature and salinity on a north-south section across the Dogger Bank between 2°40′ and 4°19′E., from observations made on 15.—21. September 1957.

The bottom layer south-east of the bank is characterized by a temperature of < 10°C.

In 1956 the existence of both regions was demonstrated by G. DIETRICH (Ann. Biol., 13). The extension of the regions were larger, the temperatures, however, lower. But no direct comparison is possible as the 1957 data were collected about two weeks later. The limit of the south-eastern bottom layer in 1957 was located at the Tail End of the Dogger Bank. In DIETRICH's Figure 36 the limit is located at Upper Scruff; therefore this cold bottom water layer is to be seen in his Figure 38.

In 1957 no cold bottom water was observed south-east of the bank (Fig. 24). At the northern edge only a sharp thermocline was formed at a depth of 43 metres, but the Dogger Bank itself was covered by homogeneous water. The effects of tidal streams produced the mixing of the water masses, thus preventing the formation of a thermocline.

E. ROGALLA

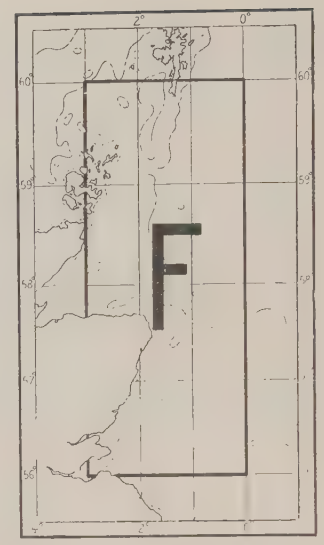


Figure 26. Location of area.

Monthly Anomalies of the Surface Temperature in an Area off the Eastern Coast of Scotland in 1957

(Figure 26; Table 3)

Table 3 gives for each month of 1957 the anomaly of the surface temperature in the area F (56°—60°N., 0°—3°W., see Figure 26); the grand monthly means for 1°-squares over the period 1876—1915 were used as standards.

Table 3. Monthly anomalies (△ °C.) and numbers (n) of observations of the surface temperature in the area F in 1957

(see Figure 26)

Jan.		Feb.		March		April		May		June		July	
△	n	△	n	△	n	△	n	△	n	△	n	△	n
0.8	33	0.6	45	0.7	40	1.2	60	1.0	64	0.9	50	0.5	44

Aug.		Sept.		Oct.		Nov.		Dec.		Average of △-values
△	n	△	n	△	n	△	n	△	n	
0.5	59	−0.2	70	0.1	33	0.3	46	0.8	32	0.6

It appears from Table 3 that positive anomalies are highly predominant, only one of the monthly anomalies being negative. Averaged for the year the anomaly is 0.6°C., as compared with 0.1°C. only in 1956.

JENS SMED

Hydrographic Conditions in the German Bight, 1957

(Tables 4–5)

Daily surface observations (8h MET) of temperature and salinity have been carried out in 1957 from 5 German lightships in the same manner in which it has been done since 1949 with the exception of "Borkumriff" where observations started in 1954. The positions are: "Borkumriff" (53°45.0'N., 6°24.2'E.); "P8" (54°16.0'N., 7°11.5'E.); "P12" (54°00.0'N., 7°51.5'E.); "Elbe 1" (54°00.0'N., 8°10.7'E.) and "Weser" (53°51.5'N., 7°53.2'E.). The observation data will be published in a year-book entitled "Meereskundliche Beobachtungen und Ergebnisse". The monthly means of surface observations, which are given in Table 4, compared with the means for the years 1950/54 represent the estuaries and coastal waters of the German Bight. Table 4 also shows the mean values of the bottom observations carried out by "Borkumriff" from which subsurface observations at various depths are made once a week only, viz., on Saturdays.

Surface temperatures in 1957 have been higher in the period February to April, inclusive, and lower in September as compared with the monthly means for 1950/54. The values for the other months are about normal.

Table 4. Monthly means of temperature and salinity at surface and bottom, for 1950/54 and 1957, at the German lightvessels "Borkumriff", "P 8", "P 12", "Elbe 1", and "Weser"

(From Deutsches Hydrographisches Institut, Hamburg)

Month		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity													
						Surface							
"Borkumriff"	1957	32.26	32.22	31.77	31.47	32.19	32.54	32.79	32.77	32.44	32.16	32.40	(32.30)
						Bottom							
	1957	32.42	32.27	31.88	31.92	32.49	32.62	32.84	32.75	32.62	32.36	32.80	(32.60)
						Surface							
"P 8"	Mean 1950/54	33.82	33.77	33.40	33.59	33.04	32.98	33.36	33.18	33.04	33.65	33.91	33.76
	1957	33.37	32.85	33.07	32.89	31.62	31.60	32.50	32.75	32.85	32.90	33.56	33.71
						Surface							
"P 12"	Mean 1950/54	32.77	32.47	32.35	32.19	31.89	32.08	32.15	32.29	32.05	32.36	33.04	32.84
	1957	—	—	—	—	—	—	—	—	—	—	32.39	32.57
						Surface							
"Elbe 1"	Mean 1950/54	31.71	33.36	32.95	31.15	31.38	31.80	31.65	32.01	31.53	31.57	32.28	32.03
	1957	31.17	31.15	31.53	29.73	29.98	30.60	31.33	31.31	30.52	29.56	30.89	31.28
						Surface							
"Weser"	Mean 1950/54	31.94	32.00	32.14	32.08	32.45	32.41	32.39	32.27	31.84	32.32	32.47	32.46
	1957	31.27	31.25	31.63	31.42	31.56	31.45	32.14	32.00	31.54	30.49	31.61	32.01
Temperature													
						Surface							
"Borkumriff"	1957	4.4	5.0	5.6	7.8	9.3	13.0	16.7	17.6	15.4	12.9	10.4	6.6
						Bottom							
	1957	4.8	5.4	6.0	7.8	8.9	12.7	16.8	17.7	16.0	13.2	10.8	6.4
						Surface							
"P 8"	Mean 1950/54	5.6	3.6	3.7	5.4	9.4	13.2	15.5	16.8	16.3	13.6	10.7	7.5
	1957	5.1	5.1	5.6	7.3	9.3	13.5	16.7	17.0	15.7	13.3	10.7	7.7
						Surface							
"P 12"	Mean 1950/54	4.9	3.1	3.5	5.6	10.1	13.5	15.9	17.1	16.1	13.1	10.4	7.2
	1957	—	—	—	—	—	—	—	—	—	—	9.9	6.9
						Surface							
"Elbe 1"	Mean 1950/54	3.9	2.4	3.3	5.8	9.3	13.2	16.3	17.3	16.0	12.8	9.7	6.2
	1957	4.4	4.3	5.0	7.3	9.4	13.1	16.3	17.0	14.9	12.3	9.8	6.1
						Surface							
"Weser"	Mean 1950/54	3.9	2.5	3.1	5.9	9.2	13.0	16.0	17.2	16.9	12.8	9.6	6.3
	1957	4.0	4.3	4.9	7.0	8.9	12.7	16.1	17.0	14.8	12.4	10.0	6.4

Table 5. Annual mean of surface temperature and salinity in 1957

Lightvessel	"Borkumriff"		"P 8"		"P 12"		"Elbe 1"		"Weser"	
	t °C.	S ‰	t °C.	S ‰	t °C.	S ‰	t °C.	S ‰	t °C.	S ‰
Mean 1950/54	—	—	10.1	33.46	10.0	32.37	9.7	31.95	9.7	32.23
Mean 1957	10.4	32.28	10.6	32.81	—	—	10.0	30.75	9.9	31.53

The 1957 surface salinities were lower throughout the year than the five-year means for 1950/54. Table 5 shows that the annual means of temperature are somewhat too high in comparison with the five-year means, and that the annual means of salinity are substantially lower, as compared with 1950/54.

G. Koopmann

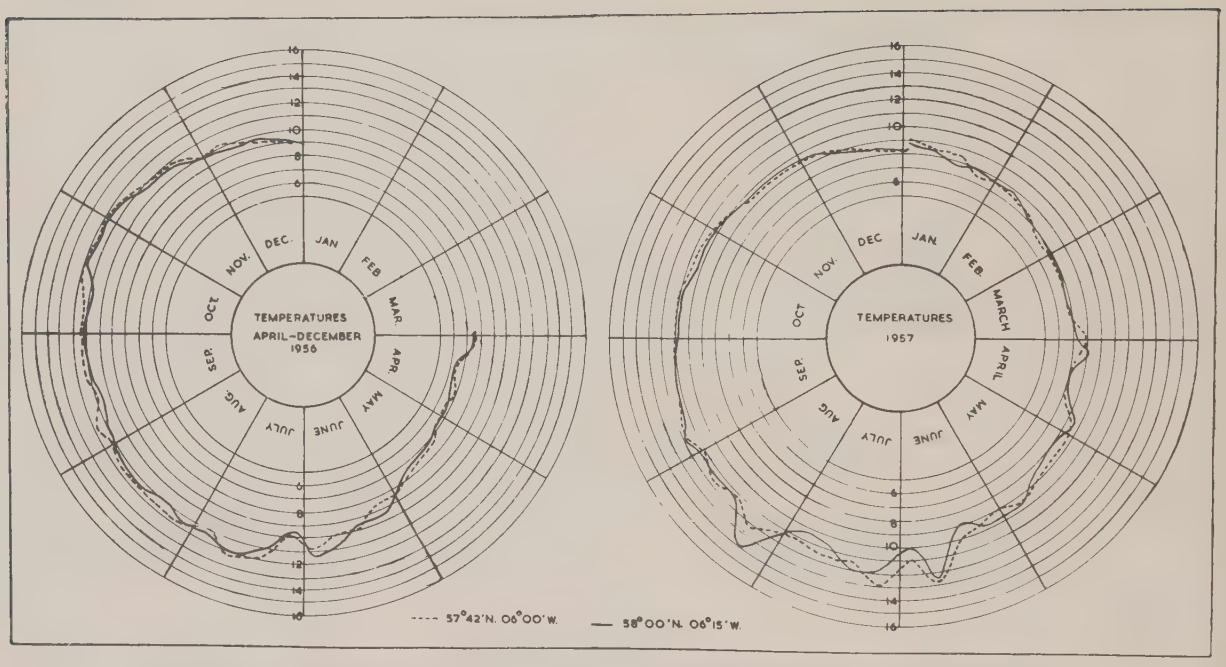
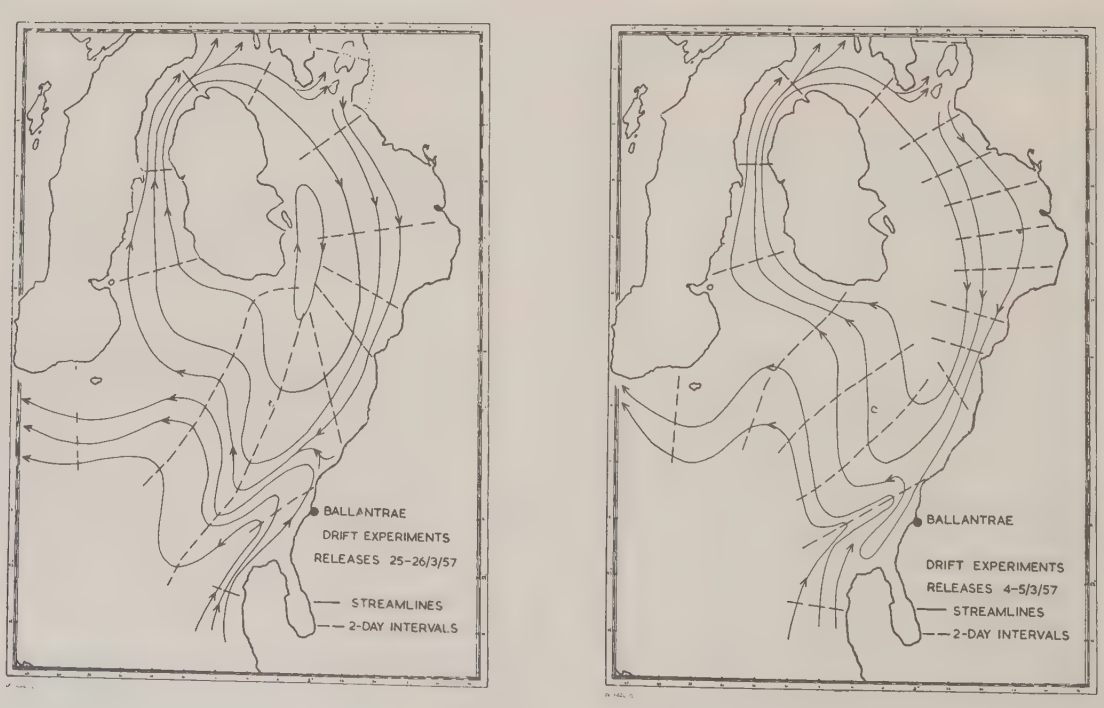


Figure 27. Sea temperature at 3 m. depth in the North Minch. Taken by thermograph.



Figures 28 and 29. Upper water movements in the Firth of Clyde deduced from drift-bottle and drift-indicator returns. March—April 1957.

Upper Water Temperature in the North Minch 1956—1957

(Figure 27)

Through the good offices of Messrs. David MacBrayne and Captain Smith of R.M.S. "Loch Seaforth", the Scottish Home Department has been able to fit a thermograph on this vessel, which runs from Kyle of Lochalsh to Stornoway. One temperature recording per week has been obtained. Figure 27 shows the results of approximately two years' recordings and gives the temperature at 3 metres depth at two selected points in the North Minch, i.e., 57°42'N., 06°00'W. and 58°00'N., 06°15'W. The observations will be continued, but the figure gives a preliminary idea, in convenient form of the temperature variations in the North Minch.

R. E. Craig

Upper Water Movements in the Firth of Clyde — March/April 1957

(Figures 28–29)

During March 1957 a large number of drift-bottles and drift-indicators were released in the south-eastern part of the outer Firth of Clyde. Analysis of the returns strongly suggested upper water movements as shown in Figures 28 and 29. A rate of movement of about 6 kilometres per day was typical. The special topic being studied was the dispersal of herring larvae from the principal spawning ground which is situated within about 2 kilometres from Ballantrae.

The earlier releases suggested that most of these larvae would be carried into the Firth, while the deduction from the second series is that most of the larvae produced near the later date would be carried out of the Firth. It will be appreciated that *upper water* movements, while deserving further study, cannot completely define the pattern of dispersion of larvae.

R. E. Craig

Hydrography of the Kattegat Area

Danish Waters

(Tables 6–7)

In the Kattegat the salinity did not deviate much from the normal conditions except for October, when a mean salinity of about $3^0/_{00}$ above the normal was recorded at the surface.

The temperatures were generally slightly above normal, especially in February and November/December.

Helge Thomsen

Table 6. Long-period means of salinity and temperature at surface and bottom at the "Anholt Nord" lightvessel, together with the deviations from the mean

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					**Surface**							
Mean	23.5	23.1	20.2	19.2	18.1	18.9	19.4	20.1	20.7	20.7	21.9	22.8
Deviation 1957	–1.2	–0.5	–1.3	1.7	2.2	0.6	0.4	0.5	0.9	2.9	0.0	–0.7
					Bottom (30 m.)							
Mean, 28 m.	31.8	32.0	32.5	33.0	33.1	32.8	32.3	31.9	31.8	32.2	32.4	32.1
Deviation 1957	1.2	0.9	0.8	0.6	0.6	0.6	0.9	0.9	0.6	0.3	0.0	1.1
Temperature					**Surface**							
Mean	2.2	1.4	1.9	4.5	9.4	14.2	16.8	16.7	14.5	10.9	7.1	4.1
Deviation 1957	0.4	1.0	0.4	0.7	–0.2	–0.3	0.6	0.6	–0.4	0.2	1.1	0.7
					Bottom (30 m.)							
Mean, 28 m.	6.1	4.7	4.3	4.3	4.9	6.7	9.7	12.7	13.1	12.1	10.2	8.1
Deviation 1957	0.4	0.4	0.4	0.1	–0.2	0.1	0.2	–0.8	0.8	0.7	1.1	1.7

Table 7. Long-period means of salinity and temperature at surface and bottom at the "Vyl" lightvessel, together with the deviations from the mean

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					**Surface**							
Mean	32.6	32.4	32.2	32.4	32.3	32.6	32.5	32.4	32.6	32.4	32.4	32.9
Deviation 1957	−0.6	−0.2	0.5	0.0	—	—	−0.2	−0.2	−0.2	0.2	0.3	−0.7
					Bottom							
Mean	32.9	32.7	32.7	32.7	32.6	33.0	32.8	32.6	32.7	32.6	32.6	33.0
Deviation 1957	−0.4	0.4	0.6	0.6	—	—	0.0	0.0	0.0	0.1	0.5	−0.6
Temperature					**Surface**							
Mean	3.2	2.2	2.6	4.8	8.8	12.4	15.2	16.1	15.0	12.2	8.5	5.4
Deviation 1957	1.3	2.1	2.0	1.8	—	—	0.9	−0.1	−0.3	0.1	1.8	1.0
					Bottom							
Mean	3.8	2.6	3.0	4.8	8.0	11.1	14.1	16.0	15.1	12.7	9.1	6.2
Deviation 1957	0.9	2.1	1.6	1.4	—	—	−0.7	−1.4	−0.3	−0.3	1.4	0.2

Swedish Waters

(Table 8)

The lightvessels "Vinga" and "Svinbådan" made observations throughout the year 1957. On the whole, the monthly means of salinity and temperature observations show small deviations only from the normal values represented by mean values for 1950—56.

The surface salinity at both lightvessels was somewhat below normal in March. Deviations in the bottom salinity at "Vinga" are inconsiderable, whereas "Svinbådan" displays deficits in June, and during the last months of the year.

Features in temperature distribution are normal, except the bottom temperatures at "Vinga" which were rather high in July and September.

N. Jerlov

Table 8. Monthly means of salinity and temperature in 1957 at surface and bottom for the Swedish lightships "Vinga" and "Svinbådan", and deviations from 1950—56 means

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					**Surface**							
"Vinga"	24.9	23.8	20.1	22.3	22.4	21.7	21.3	22.3	24.0	26.9	23.5	25.1
Deviation	−0.3	+0.7	−2.8	+0.8	+2.0	+1.5	±0	−0.6	+0.4	+1.7	−0.6	−1.0
"Svinbådan"	15.1	14.4	13.2	12.1	12.1	14.1	15.0	14.5	15.2	16.2	13.6	16.7
Deviation	−0.5	−1.1	−2.2	−0.9	−0.3	+1.2	+1.4	+0.4	+1.0	−0.5	−1.5	+0.3
					Bottom							
"Vinga"	34.1	34.0	34.5	34.3	34.4	33.8	33.4	33.6	32.7	32.5	33.3	33.8
Deviation	+0.4	−0.4	+0.3	−0.2	±0.1	±0	−0.3	+0.5	−0.8	−0.8	+0.2	+0.2
"Svinbådan"	27.4	28.8	31.7	29.5	30.0	26.7	27.6	26.5	24.0	22.4	25.6	26.6
Deviation	+0.3	−0.6	+1.1	−2.0	−1.1	−2.3	+1.0	+1.3	−1.9	−5.5	−2.7	−1.7
Temperature					**Surface**							
"Vinga"	2.8	2.6	2.1	5.1	9.1	14.0	17.3	17.4	14.0	11.2	8.2	4.6
Deviation	+0.3	+1.7	+0.6	+0.9	−0.4	−0.3	+0.6	+1.0	−0.7	−0.3	+0.9	−0.8
"Svinbådan"	2.3	2.7	2.5	5.2	8.8	14.4	18.1	17.3	13.7	10.6	8.1	4.2
Deviation	±0	+1.5	+0.5	+1.3	−0.1	−0.1	+1.5	+0.4	−0.9	−0.7	+1.2	−0.6
					Bottom							
"Vinga"	6.3	5.1	5.1	4.8	6.2	7.4	9.7	11.5	14.7	12.4	10.0	8.0
Deviation	+0.4	+0.1	+0.2	+0.3	+1.1	+1.3	+2.0	−0.2	+2.1	+0.1	+0.6	+0.3
"Svinbådan"	4.9	5.2	5.3	4.9	5.8	8.8	10.8	12.6	12.9	11.2	10.2	8.1
Deviation	−0.1	+0.4	+0.7	−0.2	−0.1	+0.9	±0	−0.5	+0.3	−0.5	+0.1	+0.8

Plankton

Plankton Investigations from Aberdeen in 1957

Phytoplankton

In the northern North Sea the spring diatom peak occurred in April and a lesser autumn peak in the period August to October. The spring figures were comparable with those in May 1956 which were greatly in excess of those in the two previous years. In the autumn the figure for all diatoms, other than *Rhizosolenia alata f. gracillima*, was above that for the previous years whilst in August the prolific production of *Rhizosolenia alata f. gracillima* was treble that of the previous highest value of September of 1954 when quantitative records were first introduced. In general the dinoflagellates repeated this pattern whilst estimates of faecal pellets, instituted in 1957, showed a peak value in June which was the month of highest copepod and lowest diatom figures.

In March the main bulk of the diatoms and faecal pellets was distributed in coastal waters, the most abundant species being *Thalassiothrix nitzschioides*, *Skeletonema costatum*, and *Thalassiosira gravida*, with *T. nitzschioides* extending also into offshore waters. This is essentially similar to previous years, *S. costatum* and *T. gravida* normally being dominant in coastal waters and *T. nitzschioides* offshore. *Halosphaera*, *Chaetoceros atlanticus*, and *C. decipiens* were present in the central area. During April the area of the Norwegian Deeps was sampled on two occasions. In the earlier survey *Coscinodiscus concinnus* was dominant near the Norwegian coast, *Chaetoceros decipiens*, *C. debilis* with *T. gravida* in the intermediate area, and *Leptocylindrus danicus* further from the coast. In the second April survey the dominance of *L. danicus* was almost absolute over the main survey area but *S. costatum* and *T. gravida* intruded apparently from the central area where they appeared to be most abundant.

During May a diatom concentration extended from Cape Wrath through the Fair Isle Channel into the North Sea. In the Minch area *Cerataulina bergonii* was dominant but *T. nitzschioides* and *T. gravida* were most abundant in the Fair Isle Channel while in the northern North Sea *T. nitzschioides* was dominant associated with high dinoflagellate values particularly off the coast of Orkney. *R. alata f. gracillima* made its usual appearance west of Shetland during the month.

Dinoflagellates particularly *Ceratium longipes*, *C. tripos*, and *C. furca* were dominant in early summer with the main concentration near the Norwegian coast and extending to the centre of the northern North Sea with diatoms lying along its fringe. There was a local northerly incursion of *R. alata f. gracillima* around Shetland and *R. styliformis* dominated water to the south of this containing concentrations of faecal pellets and *Calanus*. Between Fair Isle and Orkney the dominance of *T. nitzschioides* in May continued whilst diatom concentrations dominated by *L. danicus* still occurred off the southern Norwegian coast. The general pattern was similar to previous years but the incursion of *Rhizosolenia* from the west of Shetland appeared to be earlier than usual. During August, sampling of the Scottish coastal water showed the onset of the autumn diatom outburst associated with a great increase in the numbers of *R. alata f. gracillima*, which became the dominant species associated with *C. fusus* and *C. macroceros*. This species of *Rhizosolenia* was generally the only diatom present off the Shetland coast where it appeared in the greatest numbers associated with mixed *Ceratium* species, large numbers of *Limacina*, and some *Acanthometron*. The Fair Isle region was dominated by *C. macroceros* which extended into the North Sea and was associated with a small influx there of *Dolioletta*, *Clione*, and *Acanthometron*, whilst off the Scottish east coast small numbers of *Guinardia flaccida*, *Stephanopyxis turris*, *T. nitzschioides*, and *R. styliformis* occurred dominated by *C. fusus* and associated with high plankton volumes, *Cosmetira* and *Pleurobrachia*. It does not appear that there was any strong inflow of water into the North Sea around Shetland and if at all then it was in a restricted coastal belt. There was some evidence for concluding a flow through the Fair Isle Channel (see zooplankton below).

The Scottish east coast in autumn showed a rapid decrease in numbers of *R. alata f. gracillima* and dinoflagellates whilst other diatoms maintained their general August level. *Ceratium macroceros* was again present offshore associated with *Halosphaera* in areas dominated now by *R. styliformis* and *G. flaccida* whilst inshore mixed *Ceratium* species, i.e., *C. tripos* and *C. fusus* appeared in areas dominated by the neritic diatoms *T. nitzschioides*,

Eucampia zoodiacus and *Nitzschia seriata*. In November further separation of this system appeared with a boundary approximately in the region 57°N. Northwards *Halosphaera* and *R. styliformis* appeared away from the coast where values were very poor. Southwards the main diatom concentration was near the coast whilst offshore appeared *R. alata f. gracillima*, *Ptychocyclis*, *Salpingella*, and *Aglantha* with *C. macroceros*.

Zooplankton

The year started with poor volumes of zooplankton in the northern North Sea generally, and especially on the western side, and by March *Calanus* was moderately rich only in subsurface waters in very local patches about 120 miles west of Hanstholm Lt. and about 60 miles east of Sumburgh Head. Later in the spring the numbers quickly increased and by June *Calanus* and other small copepods, chiefly *Pseudocalanus*, were very abundant over almost the whole area north of 57°N., the exception being close to the east Scottish coast, south-east of Fair Isle and Orkney, and on the Ling Bank (58°N., 2°30′E.). Other crustaceous plankton was also rich, especially *Thysanoessa inermis* which was particularly abundant in the centre of the region investigated (i.e., between 58° and 60°N.). *Anomalocera* was unusually dense in 1957 in the surface in the south-eastern part, roughly south-east of a line from Bergen to the Firth of Forth. *Themisto* occurred in locally dense patches. The areas where this crustaceous plankton was less rich corresponded with areas of rich phytoplankton off the east Scottish coast and with masses of disintegrating jellies elsewhere.

Also found in June were numerous small specimens of *Cyanea*, the forerunners of the numerous very large specimens infesting the area in August and September. Following a decrease of *Calanus* in late summer there was a further but less marked increase in November.

During the first half of the year *Sagitta elegans* was the dominant chaetognath in the northern North Sea but by August there was evidence of some penetration of *S. setosa* towards the east Scottish area, although *S. elegans* was still dominant. During the late autumn, however, *S. setosa* further increased and was the dominant species, south and east of a line from Stavanger to the Firth of Forth.

Planktonic evidence suggests only a slight inflow into the North Sea via the north of Shetland in 1957. A few oceanic species (*Sagitta serratodentata*, *Lensia conoidea*, *Arachnactes*, and *Dolioletta gegenbauri*) were found in August to the east of Shetland but not penetrating further south than 60°30′N. A further small influx penetrated the Orkney—Fair Isle passage and a few oceanic species such as *Dolioletta gegenbauri* and *Salpa fusiformis* were found in the Moray Firth and off the east of Scotland in August and September. Some *Clione*, probably also associated with this influx, were found as far south as 55°N. by December. The 1957 inflow, at least up to November, had therefore little effect on the North Sea grounds. In 1956 there was also little penetration of oceanic species in autumn (see *Annales Biologique* for 1956) but this trickle was maintained or increased during the winter so that the remnants were present up to March 1957 (*Sulculeolaria biloba*, *Eukrohnia hamata*, *Anchialus agilis*, and *Arachnactes*). This mixing of water was probably responsible for the good crop of plankton found in the northern North Sea in June of 1957.

Over the continental shelf to the north-west of the British Isles, (in the area of the Near Northern Seas) oceanic species were far less abundant than beyond the edge of the shelf—see report to Distant Northern Seas. During the spring some residue of the 1956 Lusitanian stream was still present off the Butt of Lewis (e.g., the siphonophores *Vogtia* and *Bassia*) but did not reach as far as Shetland. By June *Dolioletta gegenbauri* was abundant beyond the edge but only sparse over the shelf, nevertheless it penetrated to a slight extent into the Moray Firth and the north Shetland by September.

This condition changed only slightly during the autumn of 1957 and at the end of the year there was still evidence of oceanic fauna along the edge of the shelf from the Butt of Lewis to Shetland. This however, contained very few *Salpa fusiformis* in contrast to the water reaching Iceland.

J. H. Fraser

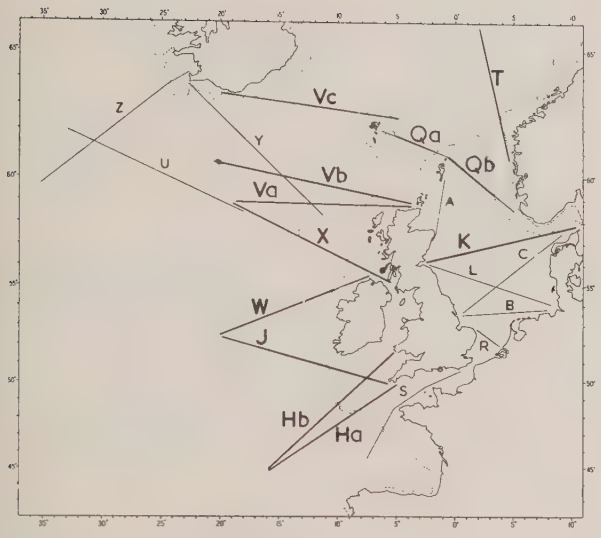


Figure 30. A chart showing the routes along which the Continuous Plankton Recorder was towed during 1957. Routes used for the histograms in the figures which follow are indicated by a thick line; in the figures and in the text they are referred to their code letters, H, J, W, X, V, Qa, T, Qb, and K.

The Continuous Plankton Recorder Survey: Plankton around the British Isles during 1957

(Figures 30–38)

The Plankton Recorder Survey has been extended in recent years; Figure 30 shows the routes from which samples were obtained during 1957. Route B, from Hull to Hamburg, was withdrawn in July to be replaced by route L, from Leith to Hamburg. Two important new routes were added during 1957; one (Z) runs south-westwards from Iceland, whilst the other (S) samples the length of the English Channel, extending into the Bay of Biscay. Details of the month-by-month sampling during 1955, 1956, and 1957 have been provided by John and Brown[1]).

Summaries of the results of the survey have been published for each year from 1948 to 1955 (Ann. Biol., **5**—**12**). Further details of the plankton collected on specific records will be supplied on application to the Officer-in-Charge, Oceanographic Laboratory, Scottish Marine Biological Association, 78 Craighall Road, Edinburgh 6, Scotland.

The present summary for 1957 is presented in the same way as those previously published in the Annales but *Euchaeta* spp. and *Tomopteris* spp. have been omitted from the figures. The standard routes are those which were used in the report for 1955, shown by heavy lines in Figure 30. As before, routes H and J have been combined; route J was sampled in May, June, October, and November, the remaining months being sampled along H with the exception of December when very few records were obtained on any routes. Route H took a slightly more northerly course than during previous years (see Ann. Biol., **12**, Figure 35). No attempt has been made to distinguish here between sampling along routes Ha and Hb as it is thought that the differences will not be important in a summary of this kind. Similarly, results from routes Va and Vb were combined. In March, the V route took the unusual course shown in Figure 30 as Vc; this has been excluded. The Q route has been divided into two parts, Qa crossing the Faroe-Shetland Channel and Qb in the northern North Sea.

When the records were received in the laboratory, a visual estimate was made of the green colour of the filtering silk, providing a rough guide to the distribution and abundance of phytoplankton. The results of this colour estimation are presented in Figure 31 which suggests that phytoplankton was rather less abundant than in previous years. The spring outburst was earlier in the North Sea than that over the deep Atlantic and there was a short lived but fairly rich crop in the late spring on the Qa route in the Faroe-Shetland Channel where Hyalochaetes, *Thalassiosira* spp., and *Nitzschia seriata* were numerous. The green colouration on the K route in late autumn and early winter was caused by dinoflagellates, mostly *Ceratium macroceros*.

There was some slight recovery in 1957, as in 1956, of the numbers of copepods which had been very low in 1954 and 1955. Figure 32 shows that the highest numbers occurred during late spring and early summer of 1957 in the northern North Sea and in the coastal part of the Atlantic route X where *Paracalanus* and *Pseudocalanus* spp. were plentiful. There were fairly high numbers of *Acartia* spp. and *Calanus finmarchicus* in the Faroe-Shetland Channel in September (Qa).

The numbers of *Calanus finmarchicus* were low in the Atlantic and, as in previous years, the major populations were found in the North Sea where the period of greatest abundance was late spring and early summer (Figures 33 and 34). The numbers were appreciably higher than in the lean years 1954 and 1955, but *Calanus* was still not so numerous as in 1950 to 1953, when all stages combined reached 500—600 per cubic metre on K and 700—900 on the T route.

The numbers of *Metridia lucens* have declined since the recent period of great abundance, 1950—1953. In 1957, short-lived and abundant populations

[1]) Bull. Mar. Ecol., **5** (40) (in the press).

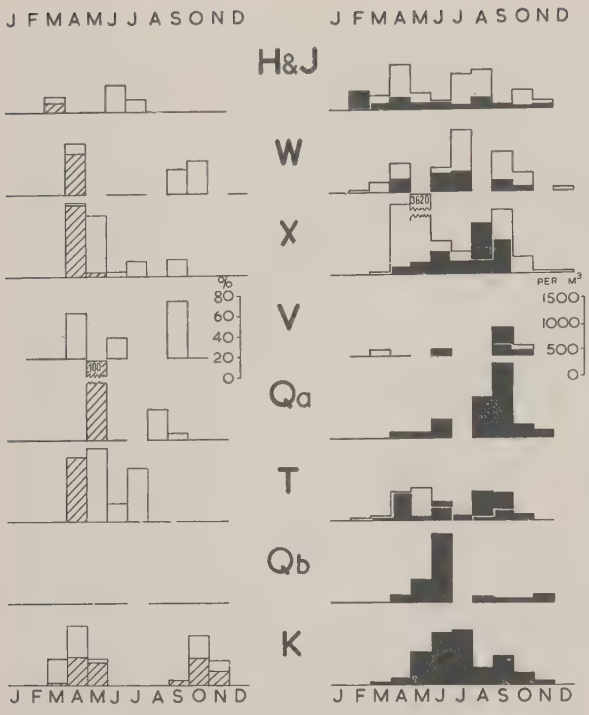


Figure 31 (left). A month-by-month estimate of the quantity of phytoplankton on the Recorder routes shown by a thick line in Figure 30. The open part of the histogram shows the percentage of the filtering silk which was coloured "pale green" and the hatched part coloured "green", as estimated by comparison with an arbitrary colour scale. A gap in the base line indicates that there were no samples in that month. Only that part of the record taken over deep water, outside the 100-fathom contour, has been included on routes H, J, W, X, V, Qa, and T. The whole of route K has been used but only that part of Qb which sampled the shallow North Sea plateau.

Figure 32 (right). Histograms showing, month by month, the numbers of Total Copepoda (all species combined) taken on the Recorder routes shown by a thick line in Figure 30. The histograms represent the number of copepods per cubic metre of water sampled along the whole length of tow on route K, along the deep Atlantic part of route Qa, and the North Sea plateau part of Qb. The two parts of the tows which lay on either side of the 100-fathom contour on routes H, J, W, X, V, and T have been separated, the solid histogram showing the numbers over the deep water and the open histogram over the shallow water of the Continental Shelf. A gap in the base line indicates that there were no samples in that month.

were found in February in the northern North Sea (Qb) and in April on the W route but elsewhere *Metridia* was unusually scarce (Figure 35); this was particularly noticeable over the deep waters of the Atlantic where high numbers have usually persisted throughout spring and early summer, see Ann. Biol., **10**, Figure 33.

Thaliacea (Figure 36) were abundant in midsummer outside the Continental Slope on the Atlantic routes but were absent from the Continental Shelf and the North Sea. The high numbers on the V route in June were found to the west of the Faroes and, between May and October, occurred even further westward on routes U, Y, and Z (Figure 30).

Planktonic "indicator" species were generally rare during 1957 in the North Sea although they were often present over deep water on the Atlantic routes. *Limacina retroversa* (Figure 37) was everywhere scarce throughout the year. *Clione limacina* (Figure 38) was exceptionally scarce in the Atlantic but a moderate population on the K route in summer suggested local breeding in the North Sea. *Tomopteris* and *Euchaeta* spp., although fairly

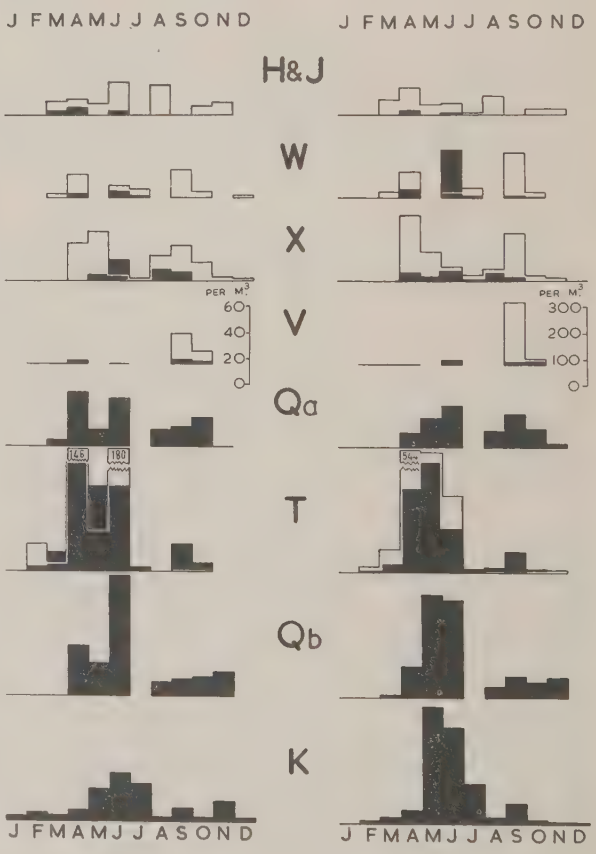


Figure 33 (left). Histograms showing, month by month, the numbers of large *Calanus finmarchicus* (copepodid stages V and VI) taken on the Recorder routes shown by a thick line in Figure 30. Details as in Figure 32.

Figure 34 (right). Histograms showing, month by month, the numbers of *Calanus finmarchicus* (all stages combined) taken on the Recorder routes shown by a thick line in Figure 30. Details as in Figure 32.

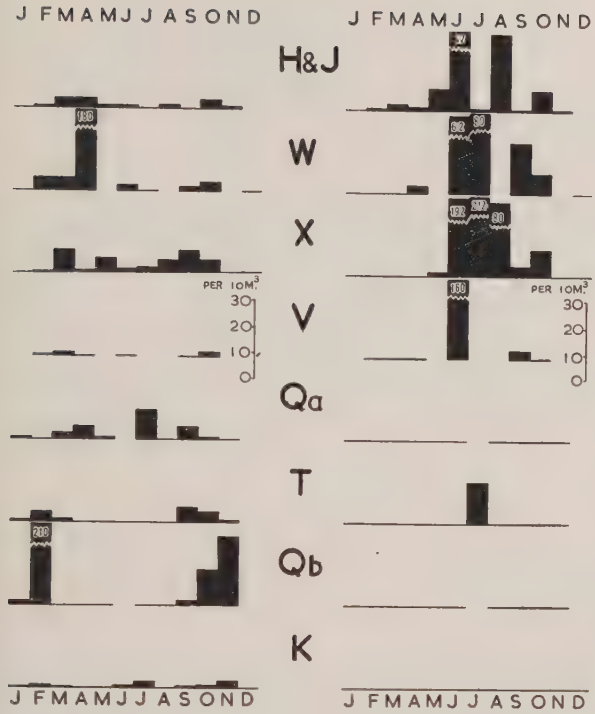


Figure 35 (left). Histograms showing, month by month, the numbers of *Metridia lucens* taken on the Recorder routes shown by a thick line in Figure 30. The histograms represent the number of organisms per ten cubic metres of water sampled along the whole length of route K and the North Sea plateau part of Qb. Only that part of the record taken over deep water, outside the 100-fathom contour, has been used from routes H, J, W, X, V, Qa, and T. A gap in the base line indicates that there were no samples in that month.

Figure 36 (right). Histograms showing, month by month, the numbers of Thaliacea taken on Recorder routes shown by a thick line in Figure 30. Details as in Figure 35.

frequent in the Atlantic, showed no signs of penetration into the North Sea.

The results suggest that the plankton around the British Isles in 1957 was, in most respects, similar to that of 1956. There does not appear to have been a strong oceanic inflow into the North Sea such as was evident in the summers of 1952, 1953, and 1954 although there may have been some signs of inflow in late autumn. *Clione limacina* which, from 1949 to 1955, arrived progressively earlier in that part of the Atlantic sampled by routes W and J, has since been progressively delayed; for example, it was first found on route J in March 1955 and in April 1956 but not until June in 1957 when it occurred over the Continental Shelf. A similar trend has been shown by other organisms, for example, *Candacia armata* and *Salpa fusiformis*. Southern species of Thaliacea (*Thalia democratica*, *Doliolum nationalis*, *Doliolina mülleri*, and *Iasis zonaria*) have penetrated further and further north in the Atlantic since 1951, reaching their northernmost limits in 1953 and 1954; the subsequent reversal of the trend in 1956 was continued in 1957.

Changes in the distribution of diatoms were in conformity with the evidence from zooplankton concerning fluctuating oceanic flow into the North Sea. *Thalassiothrix longissima* was abundant over the Dogger Bank from 1952 to 1956 but was rare in 1946—1951 and again in 1957. *Dactyliosolen mediterraneus* provided another example; this diatom was found in the North Sea only from 1952 to 1956 and was absent in 1957. It is not easy to use diatoms in the strict "indicator" concept, but these changes help to build up the picture which has been deduced from other evidence of fluctuations in the inflow of water into the North Sea.

R. S. Glover and Beatrice I. Barnes

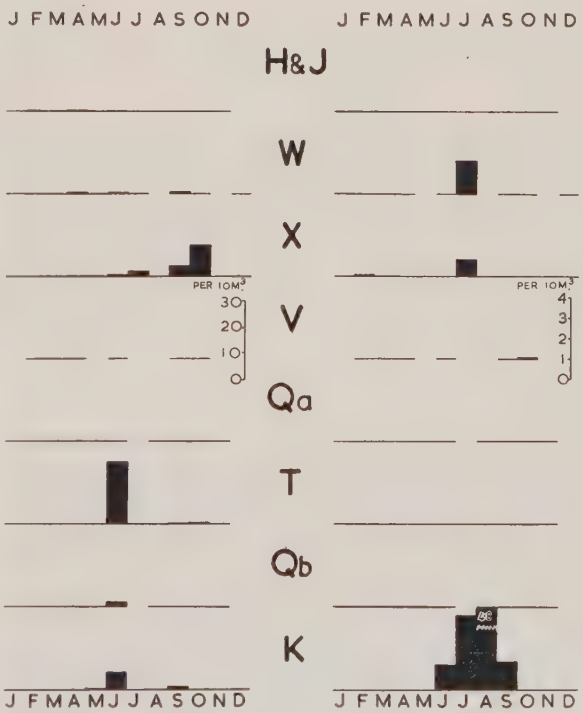


Figure 37 (left). Histograms showing, month by month, the numbers of *Limacina retroversa* larger than 1 mm. taken on the Recorder routes shown by a thick line in Figure 30. Details as in Figure 35.

Figure 38 (right). Histograms showing, month by month, the numbers of *Clione limacina* taken on the Recorder routes shown by a thick line in Figure 30. Details as in Figure 35.

The Dry Weight of Hensen-Net Plankton

(Table 9)

The collection of the dry weight of Hensen egg-net plankton from twelve stations north of the Flamborough Line and from the six stations of the regular Flamborough Line of sampling positions was continued in 1955, 56, and 57, using the same methods as in former years. The stations north of the Flamborough Line were carried out in June but the values given in Table 9 for the Flamborough Line itself refer to the means of the months June, July, and September.

For the stations north of the Flamborough Line it will be seen on comparing the values with earlier contributions that although 1955 was much lower in value than 1954 it was still substantially higher than the period 1947—51; 1956, on the other hand, resembled this period while 1957 showed a return to high values again.

In the case of the Flamborough Line itself the figures were not far from the average of the period 1947—57 but lower than the outstanding year 1953.

R. S. WIMPENNY

Table 9. Dry weights of Hensen egg-net plankton samples as mg. per m³.

	Stations N. of Flamborough Line	Flamborough Line
1955	64	54
1956	46	54
1957	68	58

Benthonic Food

Investigations of the Bottom Fauna in the German Bight, 1956 and 1957

(Figure 39; Table 10)

Since 1949 the bottom fauna of the eastern part of the German Bight has been investigated, both quantitavely and qualitatively. Up to 1955 these investigations were connected with experimental fishing on plaice. In 1956 and 1957 21 stations were worked by R/V "Uthörn". The following numbers of samples were taken by means of a 0.1 m.² van Veen grab.

	Spring	Autumn
1956	44	43
1957	42	45

Mainly in shallow waters the abundance of the bottom fauna seems to be influenced by weather conditions during the single years. Long-lasting frost periods especially reduce the bottom fauna and check its development. On the other hand, calm and warm summer months may favour the settling and development of the benthos as was observed in the summer and autumn of 1955 (see Ann. Biol., **12**: 88—89). Those effects of weather conditions on the benthal life in the area investigated are confirmed by the results of the investigations in the years 1956 and 1957. According to the increase of stock density in lamellibranchs and polychaetes, which started in the spring of 1954, and according to the good growth in summer and autumn 1955, the stocks of bottom animals were expected to be very abundant in 1956. This, however, did not appear to be the case. In consequence of the very severe winter 1955/56 the average stock density of most of the species was lower than in 1955 (Table 10 and Fig. 39). But these losses in numbers and biomass were quickly equalized by the mild winter 1956/57[1]). In autumn 1957, average values of stock numbers and live stocks (biomass) were higher and denser than ever before since autumn 1949. As shown in Table 10 *Angulus fabula*, the most important lamellibranch for food of plaice occurred even more abundantly in 1957 than in the favourable year 1955, whereas in 1956 only about 50% of the stock density of 1955 was reached. For the *Abra* species a continuous increment was observed since 1954, irrespective of the unfavourable conditions during the winter 1955/56. On the muddy offshore places most of the young *Abra* specimens belonged to the species *Abra nitida* in 1956. In autumn 1957 the grab samples taken from the muddy-sandy to sandy stations further inshore contained twice as many *Abra alba* as in the preceding year. An extraordinary high abundance was found for *Montacuta bidentata*, a tiny lamellibranch, which may, according to other authors, also live as a commensal of

[1]) Near List/Sylt surface temperatures below 0°C. were observed from the end of January up to the third decade of March 1956, but in the following winter only from 26. Dec. to 4. Jan. 1957. From about mid-January 1957 the temperatures increased steadily.

Figure 39.

Table 10

		1955		1956		1957	
		Spring	Aut.	Spring	Aut.	Spring	Aut.
Average numbers on $^1/_{10}$ m.² at all stations	Lamellibranchs ...	30.4	52.9	26.6	37.0	34.6	74.9
	Angulus	13.5	17.5	9.3	8.7	9.4	19.1
	Abra	0.4	5.3	0.6	8.0	1.7	4.1
	Polychaetes	40.8	168.5	54.9	85.3	45.4	195.7
	Crustacea	6.7	20.1	8.6	20.0	9.9	25.4
	Echinoderms	4.9	32.3	5.8	6.6	6.2	16.2
	of which *E. cordatum*	1.0	17.6	0.5	0.6	0.4	6.1
Average total stock on $^1/_{10}$ m.² (biomass in cm.³) *E. cordatum* excepted		3.2	5.0	2.7	4.6	4.8	8.1
Average stock on $^1/_{10}$ m.² (biomass in cm.³)	Lamellibranchs ...	1.9	1.6	1.3	1.7	2.2	3.2
	Polychaetes	1.1	2.5	1.1	2.0	2.1	4.1

echinoderms, tunicates, and molluscs. Of this species 978 free-living specimens could be sampled per 0.1 m.² (10 m. depth, muddy sand, Sept. 1957). Already in spring 1957, 230 *M. bidentata* were counted at the same station. The stock density in numbers of *Phaxas pellucidus* was seven times higher in autumn 1957 than in autumn 1956.

The numbers of fresh bivalves in the grab samples give an impression of the destruction of lamellibranchs by frost. The number per 0.1 m.² was on an average:—

Spring 1955 6.4 (after the cold winter 1954/55)
,, 1956 7.0 (after the very cold winter 1955/56)
,, 1957 2.3 (after the mild winter 1956/57)

The corresponding numbers for bivalves of *Angulus* were: in 1955, 1.2; 1956, 2.3; and 1957, 0.8.

The stock density of the gastropods was about the same in 1956 as in 1955; only of *Lunatia nitida* a higher abundance could be ascertained in autumn 1957, which may perhaps be ascribed to the more ample lamellibranch food.

The polychaetes as a whole, attained in autumn 1956 about 50% of the stock numbers of autumn 1955. Only in *Scalibregma inflatum* a considerable increase could be stated in autumn 1956. This polychaete is only found in the grab samples taken in summer and autumn from muddy soil in the deeper waters around Helgoland. In autumn 1956, a total of 234 *Sc. inflatum* could be collected, i.e., the stock number of this species was 1.4 times as high as in all samples taken in the area from 1949 to 1955. In autumn 1957, the abundance of the polychaetes reached the highest level observed

during the time of investigation. The main share is contributed by *Spiophanes bombyx* and *Pectinaria koreni*. The stock numbers of *Sp. bombyx* confirm the correctness of the observations on *Abra alba* in regard of the influence of hibernation conditions on bottoms of different quality and depth. While in autumn 1956, after the severe winter 1955/56, as many as 416 *Sp. bombyx* could be counted in a single sample of 1/10 m.² at greater depth (e.g., 40 m.) only, the stock numbers at the sandy, shallower stations were comparatively small. In autumn 1957, on the other hand, the grab samples of the inshore and more sandy places contained large numbers of *Sp. bombyx*. Almost 1000 *Spiophanes* were picked out of one single sample (11 m. depth, fine muddy sand). For *Pectinaria koreni*, the same thing was observed.

In the crustacea (mainly the amphipods: *Ampelisca brevicornis*, *Urothoe poseidonis*, and *Bathyporeia guilliamsoniana*) the abundance in the autumn months of the last four years appears to be nearly constant (see Fig. 39). In contrast with crustacea, the echinoderms seem to be very sensitive to weather influences. Thus, *Echinocardium cordatum* was more seriously reduced in numbers than any other bottom invertebrate. The young Echinocardia of autumn 1955 (up to 170 specimens per 1/10 m.²) have been killed off by the frost. The stock numbers of *E. cordatum* in spring and autumn of 1956 showed the lowest figures ever observed since 1949. The average size of *Echinocardium cordatum* was in the spring of 1956 31.8 mm., and in autumn 30.1 mm., in contrast to the samples of autumn 1955, in which only young specimens up to 10 mm. length could be found. In spring of 1957, only large specimens of *E. cordatum* could be found (average length = 33.5 mm.); in autumn 1957, 67.4% of the Echinocardia were smaller than 10 mm. For both *Ophiura* species, *O. texturata* and *O. albida*, a strong numerical increase could be recorded.

E. Ziegelmeier

THE FISH

Plaice

German Plaice Investigations in 1957

(Figures 40–46; Tables 11–19)

Investigations on the plaice population of the south-eastern North Sea were continued under the new plan established in 1956. The R/V "Anton Dohrn" worked from 26. June to 5. July in very fair weather. The area covered by this cruise was the same as in 1956, apart from the westernmost stations Outer Silverpit, Dogger Bank, and Mittelriff where no plaice were fished in 1956. 34 stations were occupied, 12 of them being former "Uthörn" stations. At each of the stations "Nordhafen innen" (N. of Helgoland) and "Horns Nordgrund" 9 hauls were made with an interval of three hours in order to obtain information about the feeding rhythm of the flatfish (Hempel). At the stations List II, Westerland II, and Amrum II comparative fishing was carried out with the "Anton Dohrn" and "Uthörn". Both ships made 2 hauls of half an hour's duration at each station. On this cruise 7,843 plaice were caught and measured, of these 2,721 fish were examined for age determination.

Investigations at the Bremerhaven fish market were intensified. In 1957 the landings of 42 high-sea cutters were investigated with regard to age and length composition, while in 1956 only 16 cutters were investigated. Age determinations and measurements were made on 20,909 specimens (in 1956: 7,495).

Research-ship investigations

(a) Age composition

When considering the plaice population of the German Bight (the area covered by "Uthörn" in the period 1948 to 1955) it is observed that the age composition in 1957 is quite different from that in 1956 (Table 11 and Figure 40). About one quarter of the stock consists of age-group I (7% in 1956). The importance of the two following groups, II and III, had decreased remarkably, while the percentages of the older fish showed a slight increase.

On the fishing places of the German cutters outside the German Bight age-group IV was the richest, forming 42% of the stock, the same year-class predominating in 1956 as age-group III. The proportion of the 2-year-old fish was twice that in 1956; this fact corresponds well with the heavy decline of this age-group in the German Bight. Fish belonging to the VI-group and older amounted to 2% only, while there were 7% in the preceding year.

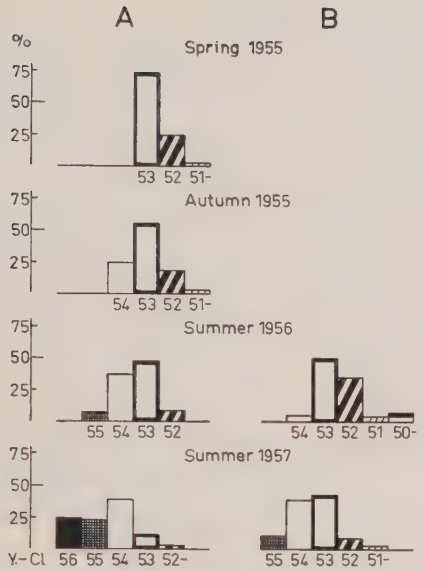


Figure 40. Age composition (%) of plaice in the catches of "Uthörn" (1955) and "Anton Dohrn" (1956 and 1957).
A = catches from the German Bight.
B = catches from the cutter fishing places.

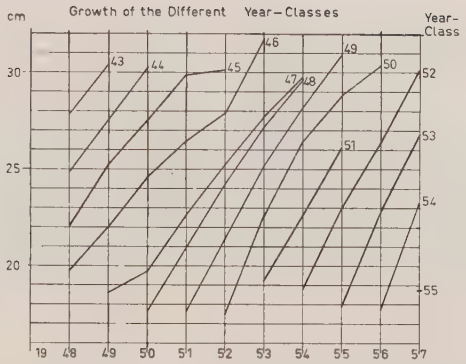


Figure 41. Growth-curves of the 1943 to 1955 year-classes in the German Bight.

(b) Growth

The fast growth-rate of the plaice, established in recent years, continued as shown in Figure 41 and Table 12. In 1957 the average length of the single age-groups was still somewhat higher than in 1956, in the German Bight as well as outside. This might —at least partly—result from the declining density of the stock.

(c) Density of stock and relative strengths of year-classes

The plaice stock in the German Bight has decreased noticeably in density from 1956 to 1957 as judged by the decline in catch per hour's fishing from 589 fish to 367 (Figure 42 and Table 13). The 1954 and 1953 year-classes especially showed a remarkable decrease in numbers. They seem to have undertaken a large-scale migration to deeper waters. This supposition is correlated with the composition of the catches taken outside the German Bight where the plaice of these year-classes, 1954 especially, increased in numbers. The 1955 year-class seems to have left the nursery grounds earlier than usual.

In the coastal waters the decline in older fish is nearly balanced by the very high numbers of I-group fish; the 1956 year-class seems to be rich.

Table 11. Age composition (%) of plaice in the catches from 1955 to 1957

	Age-groups						
	I	II	III	IV	V	VI+	Total
Spring 1955	+	73	24	1	1	1	2,941
Autumn 1955	24	55	18	1	1	1	2,737
Year-class	*1954*	*1953*	*1952*	*1951*	*1950*	*1949*	–
Summer 1956	7	37	47	8	1	+	3,535[1])
	—	5	49	35	4	7	442[2])
Year-class	*1955*	*1954*	*1953*	*1952*	*1951*	*1950*	–
Summer 1957	24	23	39	11	2	1	2,201[1])
	+	10	38	42	8	2	501[2])
Year-class	*1956*	*1955*	*1954*	*1953*	*1952*	*1951*	–

[1]) Stations of the German Bight (former "Uthörn" stations).

[2]) Stations of the cutter fishing places outside the German Bight.

Table 12. Average length (in cm.) of the single age-groups from 1955 to 1957

	Age-groups						Mean length of the total catch
	I	II	III	IV	V	VI	
Spring 1955	—	16.7	22.3	24.9	27.2	—	18.3
Autumn 1955	14.9	19.1	23.7	27.4	30.3	30.9	19.3
Year-class	*1954*	*1953*	*1952*	*1951*	*1950*	*1949*	
Summer 1956	10.9	17.7	22.8	26.3	26.2	30.4	20.7[1])
	—	20.1	23.9	28.5	32.7	—	26.3[2])
Year-class	*1955*	*1954*	*1953*	*1952*	*1951*	*1950*	
Summer 1957	12.7	18.7	23.2	26.8	30.1	—	20.3[1])
	—	20.9	25.0	28.8	32.6	—	27.1[2])
Year-class	*1956*	*1955*	*1954*	*1953*	*1952*	—	

[1]) and [2]) see notes to Table 11.

In order to continue the estimates for the relative strength of the year-classes from their abundance in the II and III groups the 1954 year-class must be added to the list (see Ann. Biol.,

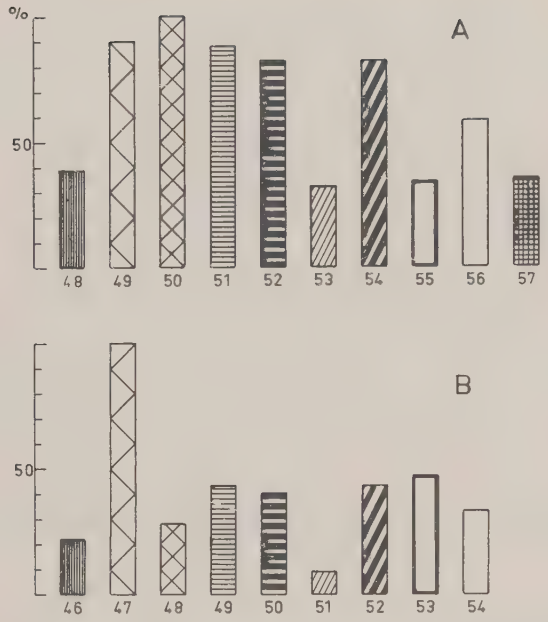


Figure 42. Relative density of the plaice stock (A) and relative strength of the year-classes (B).

Table 13. Catch per hour

	Age-groups						Mean catch per hour
	I	II	III	IV	V	VI+	
Spring 1955	—	307	103	6	3	1	420
Autumn 1955	69	158	52	3	2	4	288
Year-class	*1954*	*1953*	*1952*	*1951*	*1950*	*1949*	–
Summer 1956	39	217	275	47	4	7	589[1])
	—	2	19	14	2	3	40[2])
Year-class	*1955*	*1954*	*1953*	*1952*	*1951*	*1950*	–
Summer 1957	88	84	144	42	6	3	367[1])
	+	5	18	20	4	1	48[2])
Year-class	*1956*	*1955*	*1954*	*1953*	*1952*	*1951*	–

[1]) and [2]) see notes to Table 11.

13: 85) giving an index of 33. This figure means that the strength of the 1954 year-class amounted to about 33% of that of the richest year-class since the war (the 1947 class). That this figure is not as high as expected in 1956 may be due to the earlier migration of the 1954 year-class.

(d) Length distribution

In 1957 the mean length of plaice in the German Bight was 0.4 cm. lower than that in 1956. This decrease is smaller than was expected in consequence of the intensive renewal of the stock. On the other hand, the compensating effect of good growth in the preceding year must be taken into consideration. The rapid growth of the plaice also caused an increase, from 14% in 1956 to 19.4% in 1957, in the numbers of marketable fish

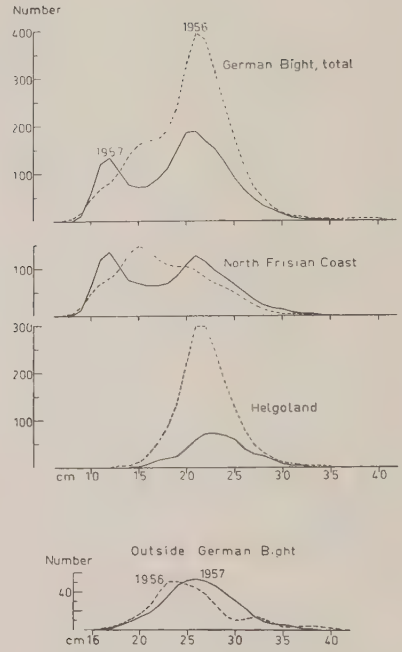


Figure 43a. Length distribution of the plaice catches in the German Bight in 1956 and 1957.

Figure 43b. Length distribution of the plaice catches outside the German Bight in 1956 and 1957.

caught (Table 14 and Figs. 43a and b). Outside the German Bight both the mean length and the proportion of marketable fish were somewhat higher than in 1956 (27.1 to 26.3 cm. and 68.6% to 55%, respectively).

(e) Comparative fishing

On "Uthörn" the same kind of gear was used from 1948 to 1955, while on the "Anton Dohrn" a narrow-meshed covered cod-end and a narrow-meshed inner cod-end were used, as was the practice in 1956 also.

Naturally the small-meshed nets of "Anton Dohrn" retained more specimens of the length group under 15 cm. than those of "Uthörn". Fish of 15 to 20 cm. were taken in higher numbers by "Uthörn" than by "Anton Dohrn"; the length groups 21 to 26 cm. were prevalent in the catches of the latter ship. Fish of over 26/27 cm. were caught in nearly equal numbers by both ships. From Table 15 and Figure 44 we may derive that the selectivity is similar in all single hauls and therefore it may be permissible to take these results into consideration, although the numbers of hauls were small. Nevertheless, it seems necessary to continue comparative fishing in 1958.

Table 14. Percentage ratio of plaice of more than 25 cm. length

Age-group	I	II	III	IV	V	VI	VII	VIII	Total %
Spring 1955	0	0	11	39	83	75	100	100	3.1
Autumn 1955	0	1	33	81	100	90	80	100	9.0
Year-class	*1954*	*1953*	*1952*	*1951*	*1950*	*1949*	*1948*	*1947*	
Summer 1956	0	0	15	63	68	100	100	100	14.0[1]
	—	0	29	88	94	100	100	100	55.0[2]
Year-class	*1955*	*1954*	*1953*	*1952*	*1951*	*1950*	*1949*	*1948*	
Summer 1957	0	+	21	77	100	100	100	100	19.4[1]
		2	49	94	100	100	100	100	68.6[2]
Year-class	*1956*	*1955*	*1954*	*1953*	*1952*	*1951*	*1950*	*1949*	

[1]) and [2]) see notes to Table 11.

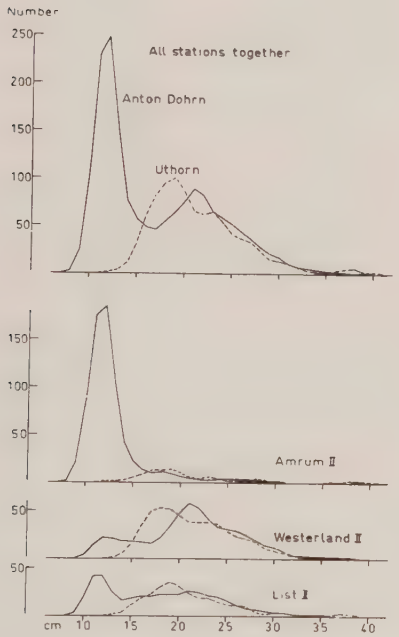


Figure 44. Comparative fishing between "Anton Dohrn" and "Uthörn" (smoothed curves).

Table 15. Comparative fishing between "Anton Dohrn" (A.D.) and "Uthörn" (Uth.). The two catches of each station are taken together

Stat.	List II		Westerland II		Amrum II		Total	
cm.	A.D.	Uth.	A.D.	Uth.	A.D.	Uth.	A.D.	Uth.
9	1	—	—	—	6	—	7	—
10	12	—	1	—	68	—	81	—
11	50	—	16	—	200	—	266	—
12	50	—	27	—	231	1	308	1
13	17	1	19	1	77	1	113	3
14	16	1	18	4	39	1	73	6
15	15	9	18	12	17	4	50	25
16	25	24	17	34	14	10	56	68
17	13	15	15	59	7	8	35	82
18	26	35	18	49	13	14	57	98
19	21	36	38	57	10	11	69	104
20	18	33	42	45	3	14	63	92
21	30	22	70	32	6	1	106	55
22	26	14	51	42	4	3	81	59
23	17	25	41	38	1	10	59	73
24	24	13	29	37	7	1	60	51
25	15	10	33	30	3	1	51	41
26	12	14	29	17	4	1	45	32
27	6	11	24	27	6	2	36	40
28	9	2	20	15	1	2	30	19
29	4	2	10	10	2	2	16	14
30	3	3	17	9	1	1	21	13
31	4	5	3	6	1	—	8	11
32	—	1	5	2	—	1	5	4
33	2	1	4	2	1	—	7	3
34	—	1	—	1	1	—	1	2
35	2	1	4	1	—	—	6	2
36	—	—	1	1	—	1	1	2
37	—	5	—	2	1	—	1	7
38	—	1	1	1	—	3	1	5
39	1	—	—	—	1	2	2	2
40	—	—	1	—	—	1	1	1
41	—	—	—	—	2	—	2	—
42	—	—	—	—	1	—	1	—
Total	419	285	572	534	728	96	1719	915

(f) Repeated hauls at "Nordhafen innen" and "Horns Nordgrund"

The repeated hauls made at three-hour intervals in the course of 24 hours at the two stations gave very remarkable results. We see from Table 16 and Figure 45 that in both series the catches made at 7 a.m. and 7 p.m. were the poorest, while those made at daytime and at about midnight were the best. At the first station the maximum catch at 10 p. m. was 23 times as high as the minimum catch taken at 7 p.m. It may be noted that similar features were found in the dab catches also. At present we cannot offer an explanation of these diurnal fluctuations in the yield. Earlier observations do not tally with the present results; at any rate it seems to be necessary to repeat these experiments on a larger scale.

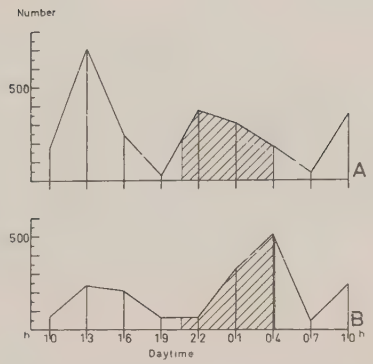


Figure 45. Diurnal variations in the catches at the stations "Nordhafen innen" (A) and "Horns Nordgrund" (B).

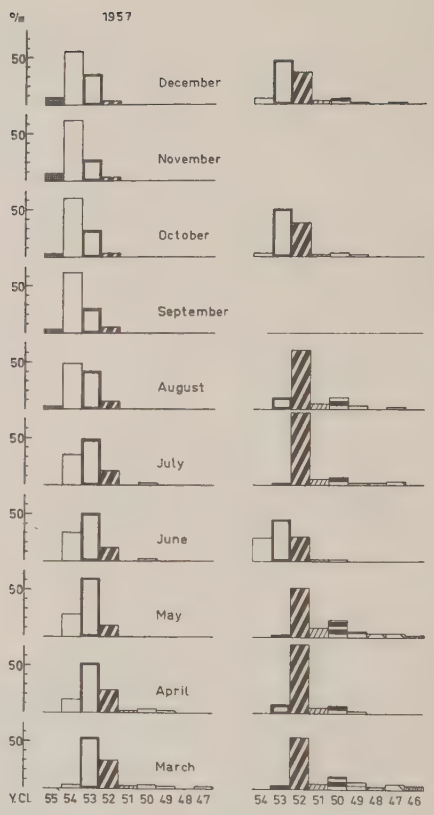


Figure 46. Age composition of the cutter landings in 1956 and 1957 in the single months.

Table 16. Numbers and length distribution of plaice caught at "Nordhafen innen" and "Horns Nordgrund" at different hours of the day

	"Nordhafen innen"									"Horns Nordgrund"								
Hours	10	13	16	19	22	01	04	07	10	10	13	16	19	22	01	04	07	10
cm.																		
12	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
13	1	7	—	—	—	—	2	—	—	—	—	—	—	—	2	—	—	—
14	—	5	—	—	—	—	—	—	—	—	2	2	—	3	2	—	1	2
15	1	12	—	—	—	—	—	—	3	—	—	—	1	—	2	1	—	—
16	7	17	—	—	2	—	—	—	6	—	—	2	2	1	10	—	—	—
17	16	22	4	—	12	4	8	2	14	2	7	8	4	4	12	2	1	7
18	12	57	32	2	26	12	4	2	14	5	17	24	10	3	19	28	2	26
19	20	86	28	8	46	30	8	6	37	6	31	34	14	15	42	71	8	37
20	19	94	26	6	34	40	12	2	46	12	51	44	11	7	76	86	8	40
21	24	96	42	2	70	46	24	10	46	9	31	25	7	18	45	76	5	28
22	18	76	30	4	54	48	32	4	48	9	17	24	4	5	38	75	5	42
23	17	113	38	8	34	50	26	6	34	11	27	12	8	1	25	63	7	32
24	9	57	24	—	42	24	22	4	17	3	29	14	1	2	19	42	3	16
25	5	20	10	—	32	22	12	—	28	5	12	12	2	6	21	30	5	11
26	7	35	10	—	12	18	14	—	11	5	7	4	1	—	10	30	2	9
27	2	7	2	—	12	6	8	—	11	—	2	2	1	—	4	3	2	2
28	5	5	2	2	4	2	4	—	9	—	3	4	—	—	4	7	—	—
29	1	—	2	—	—	—	2	—	—	—	—	2	—	—	—	—	1	—
30	1	—	—	—	2	2	—	—	3	—	—	—	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
37	—	—	2	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
Total	166	711	252	32	382	304	178	36	361	68	236	213	66	66	331	514	50	252

Table 17. Market investigations on plaice. Number of age determinations in 1957

J. No.	Date	Locality of catch	Market categories Ia	I	II	III	IV	Total
1	6. 3.	Schlick Bank	89	93	77	121	152	532
2	11. 3.	Schlick Bank	95	88	150	112	155	600
3	30. 3.	White Bank	85	102	170	120	163	640
4	5. 4.	Monkey Bank	94	104	120	97	117	532
5	6. 4.	Horns Reef L.V.	46	100	171	119	169	605
6a	15. 4.	Coffee Soil	28	103	161	115	—	407
6b	15. 4.	Sylt Outer Ground	—	—	—	—	141	141
7	17. 4.	"Westkante"	110	118	114	104	—	446
8	24. 4.	Coffee Soil	47	105	159	94	144	549
9	30. 4.	Horns Reef/Sylt Outer Ground	—	82	183	123	174	562
10	2. 5.	Sylt Outer Ground	—	49	84	115	185	433
11a	8. 5.	Horns Reef	—	—	—	—	170	170
11b	8. 5.	Coffee Soil	22	118	94	122	—	356
12	9 5.	Coffee Soil	13	109	85	83	160	450
13	13. 5.	S. of Vyl L.V.	—	—	179	121	168	468
14	16. 5.	ca. 10 miles N. of Norderney	—	101	155	115	183	554
15	18. 5.	Horns Reef	—	39	96	119	156	410
16	20. 5.	Vyl L.V.	—	32	96	126	181	435
17	23. 5.	Vyl L.V.	—	—	113	132	171	416
18	27. 5.	N. of Horns Reef L.V.	—	35	104	121	122	382
19	3. 6.	Coffee Soil	121	103	114	—	—	338
20	11. 6.	Horns Reef	—	21	163	124	166	474
21	14. 6.	Muschel Ground	—	—	115	112	161	388
22	18. 6.	S. of Vyl L.V.	—	—	187	131	177	495
23	19. 6.	Middle Bank	104	85	131	106	151	577
24	5. 7.	Clay Deep/Monkey Bank	35	47	152	100	151	485
25	8. 7.	Coffee Soil/Sylt Outer Ground	110	124	118	102	151	605
26	18. 7.	Monkey Bank	101	139	134	102	—	476
27	30. 7.	East Ground	—	42	96	127	176	441
28	5. 8.	55°N.—3°45′E.	—	71	95	128	175	469
29	13. 8.	55°N.—5°E.	—	8	85	129	62	284
30	14. 8.	Clay Deep	8	43	145	108	150	454
31	19. 8.	Coffee Soil/Horns Reef	47	90	153	97	170	557
32	19. 9.	Horns Reef	—	57	164	121	165	507
33	4. 10.	Horns Reef	—	100	151	96	138	485
34	10. 10.	Horns Reef	—	106	149	103	137	495
35	14. 10.	Clay Deep	124	128	160	113	157	682
36	18. 10.	Middle Bank	102	134	124	35	—	395
37	21. 10.	Horns Reef	—	115	154	111	137	517
38	28. 10.	Horns Reef/North Ground	—	109	160	112	146	527
39	6. 11.	Horns Reef/North Ground	—	107	165	111	156	539
40	18. 11.	Horns Reef	7	103	157	101	137	505
41	28. 11.	Horns Reef	—	115	173	114	149	551
42	4. 12.	North Ground	32	111	167	110	155	575
		Total	1,420	3,336	5,723	4,552	5,878	20,909

Market investigations

Because of the lack of detailed German cutter statistics it is not possible to compute the age composition and length distribution of plaice in the monthly cutter landings. It has been tried to group the samples according to areas, as done in 1956. Most of the catches were, however, made on two or more different fishing grounds, therefore a grouping of the samples according to areas, was impossible; for this reason the samples have been grouped per month (Tables 17—19 and Fig. 46).

In order to obtain reliable data we also summed up the 1956 figures on a monthly basis. This rough method cannot give us a very reliable picture of the age and length composition of the whole plaice stock in the south-eastern part of the North Sea, as the single fishing grounds have not equally been taken into consideration. This will exert an influence on the average lengths of the single age-groups, for fishes from different areas with very diverging growth-rates have been lumped. But at the moment a more detailed analysis of the material is not possible.

In 1956 the 1952 year-class was—at least up to August—the most predominant one in the cutter landings, in the last months of the year, however, the 1953 year-class prevailed to some extent. The proportion of the older fish was relatively high,

Table 18. Age composition (%) of the cutter landings in 1956 and 1957

Age-group	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII+	Total
January 1956	—	+	10	14	34	17	6	16	2	1	+	6,178
March 1956	—	4	55	7	14	8	3	6	2	1	+	13,811
March 1957	—	3	54	30	3	4	2	1	2	+	+	36,144
April 1956	—	9	73	6	8	2	1	1	+	+	+	9,173
April 1957	+	13	52	23	3	4	1	1	1	+	1	32,872
May 1956	—	2	52	10	18	7	3	5	1	1	1	5,633
May 1957	—	23	62	13	+	1	+	+	+	+	+	98,130
June 1956	25	43	27	1	2	+	+	1	—	—	—	30,081
June 1957	—	30	51	14	1	2	1	+	1	+	+	46,038
July 1956	—	3	76	7	7	2	1	3	1	+	+	11,791
July 1957	32	48	15	1	2	1	+	1	+	+	+	30,464
August 1956	—	11	62	7	11	4	1	3	1	—	—	22,350
August 1957	3	47	39	9	+	1	+	+	+	+	+	52,364
September 1956 ..	—	—	—	—	—	—	—	—	—	—	—	—
September 1957 ...	4	63	27	6	+	+	+	+	+	+	+	13,475
October 1956	4	49	37	3	4	1	1	1	+	+	+	32,511
October 1957	4	61	28	5	+	1	+	+	+	+	+	115,673
November 1956 ..	—	—	—	—	—	—	—	—	—	—	—	—
November 1957 ..	9	64	23	4	+	+	+	—	+	+	+	99,457
December 1956 ...	6	45	35	4	5	2	1	2	+	+	+	7,839
December 1957 ...	9	56	31	4	+	+	+	+	+	+	+	24,764

Table 19. Average length at a given age in the cutter landings (cm.)

Age-group	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average of the total
January 1956	—	—	29.9	34.8	35.5	35.7	37.3	37.6	43.3	48.4	—	35.7
January 1957	—	—	—	—	—	—	—	—	—	—	—	—
March 1956	—	26.8	29.7	34.0	36.7	39.0	41.7	43.2	45.4	47.8	49.9	33.3
March 1957	—	28.0	29.6	33.2	40.4	43.0	43.3	44.6	44.4	48.9	52.1	32.4
April 1956	—	—	28.1	30.7	33.8	37.9	—	41.6	—	—	—	29.0
April 1957	—	28.4	30.2	34.1	37.9	41.9	44.3	46.0	45.5	47.7	50.0	32.2
May 1956	—	26.0	30.6	35.7	37.7	39.6	43.0	44.3	48.8	49.8	55.7	34.7
May 1957	—	26.9	29.4	31.8	34.6	35.7	34.6	38.9	35.4	40.7	43.8	29.2
June 1956	18.0	22.8	26.4	29.0	29.9	34.4	33.6	35.8	—	—	—	23.0[1]
June 1957	—	27.5	29.1	32.1	35.6	40.2	44.4	45.9	44.5	50.5	51.8	29.7
July 1956	—	27.7	30.6	33.3	36.2	40.6	45.3	43.6	49.1	51.0	—	32.1
July 1957	—	28.1	30.6	35.0	38.6	42.0	44.1	47.3	46.0	51.3	53.2	31.1
August 1956	—	28.4	31.5	33.6	35.6	36.4	44.6	41.7	49.1	51.3	53.9	32.6
August 1957	25.6	27.3	30.4	32.8	36.6	36.3	42.0	41.4	43.9	—	—	29.1
September 1957 ..	26.5	28.3	31.5	33.2	—	—	—	—	—	—	—	29.4
October 1956	—	27.9	29.9	32.2	35.7	40.3	42.2	44.5	48.8	55.5	—	29.6
October 1957	27.1	29.5	32.7	35.4	42.0	40.7	45.8	48.4	48.5	51.5	53.6	30.9
November 1957 ..	26.8	29.3	32.2	34.6	—	—	—	—	—	—	—	30.0
December 1956 ...	26.0	28.6	32.2	35.5	39.1	41.6	—	43.5	—	—	—	31.3
December 1957 ...	27.1	28.9	30.6	34.1	—	40.4	—	—	—	—	—	29.5

[1]) one single catch including undersized fish.

and the richest post-war year-class (1947) was still present in very high numbers. Two-year-old fish were very scarce.

During 1957 the 1952 year-class decreased slowly until reaching 4% only. At the beginning of the fishing season the 1953 year-class was predominant in the catches, afterwards it fell off. On the other hand, the 3-year-old fish of the 1954 year-class became more and more predominant—and more so than the corresponding age-group in 1956. The 2-year-old fish came to the fore in increasing proportions. Fish older than 5 years were always scarce, but the rich 1947 year-class, now ten years old, is still predominant among the old specimens caught. In 1957 it was also possible to confirm the fact that the 1951 year-class is the poorest of all the post-war year-classes. The increasing occurrence in the open sea of the 1954 year-class corresponds well with its decline in the German Bight, as shown by the "Anton Dohrn" catches.

ADOLF KOTTHAUS

Danish Plaice Investigations

(Table 20)

Young plaice in the Danish Waddensea

The results are reported and a new method for estimating the strength of the individual year-classes is suggested in "Meddelelser fra Danmarks Fiskeri- og Havundersøgelser", N.S., **2** (20). Copenhagen, 1958.

The stock of plaice off Esbjerg

Trawling with a 50 ft. otter-trawl with a 9 mm. mesh in the cod-end was carried out on 3. and 4. July in the southern Horns Reef area. 22 hauls of 10 minutes duration were made. In depths less than 10 m. 649 plaice were caught per hour (mean for 1950—57, 581 per hour). In depths from 10 m. to 29 m. the number per hour was 273 (mean for 1950—57, 330 per hour). In depths less than 10 m. the age distribution (numbers caught per hour) was:—

	0	I	II	III
1954	0	256	58	0
1955	0	236	682	42
1956	0	168	213	3
1957	120	519	8	2

In depths from 10 to 29 m. the corresponding numbers were:—

	0	I	II	III	IV	V
1954	0	27	17	1	2	4
1955	0	48	298	103	2	1
1956	0	43	167	39	14	0
1957	1	217	20	29	5	1

The predominance of quite small plaice (0- and I-group) in 1957 is remarkable. More evidence should be gathered before deciding whether the unusual abundance of small plaice indicates the arrival of new strong year-classes on the Horns Reef fishing grounds.

As usual in the Horns Reef area the few (23) marketable plaice caught (26 cm. and above) belonged to the III-group and the IV-group. The percentage age distribution was as follows:—

	III	IV	V	VIII
1955	82	9	7	2
1956	33	65	2	—
1957	43	48	9	—

The 1952 year-class (in 1957 the V-group) predominated among the marketable fish in 1955 and 1956 but, as might be expected, had vanished in 1957.

Landings of plaice at Esbjerg

Many cutters had operated in various parts of the North Sea on the same trip and landed a mixture of plaice from several localities. Such landings must be discarded, so that the total number of landings available for analysis was 219 against 347 in 1956. The information was collected in five periods from April to October. Material was collected during about a week each time. As in the preceding years a distinction could be made between landings from areas in which small plaice (category 4) predominated and landings from areas in which large plaice (category 1 and 0) predominated. The mean weight in each category was:—

Category	11 landings dominated by small plaice Mean weight, g.	5 landings dominated by large plaice Mean weight, g.
0	—	1311
1	595	729
2	424	555
3	302	397
4	202	272

The estimate of the mean weight of plaice landed from each area (Table 20) is based on the mean weight in each market category, as shown above.

Plaice from areas in which category 4 predominates seems to have been slightly smaller in 1957 than in 1956. Plaice from areas in which category 1 and 0 predominates seem to have been larger in 1957. It schould be remembered, however, that few landings of large plaice were available and that great local variation in the size distribution occurs within the area (the Dogger Bank and the northern North Sea) in which large plaice predominate.

Age analyses were carried out on samples from 17 landings. 2,730 plaice were dealt with. Landings

Table 20. Weight distribution and mean weight of plaice from various localities in the North Sea. 219 Esbjerg landings, April—October 1957 ( ) = corresponding values for 1956

	Depth (fathoms)	Number of landings	Weight distribution, % Cat. 4	Cat. 3	Cat. 2	Cat. 1	Cat. 0	Mean weight g.
Horns Reef	5—24	138	77 (74)	20 (22)	3 (3)	1 (1)	0 (0)	220 (235)
Clay Deep–Holland	13—27	36	70 (72)	22 (20)	6 (5)	2 (2)	1 (1)	230 (241)
Bløden Ground–E.edge of the Tail End	20—30	4	44 (49)	34 (35)	13 (10)	9 (5)	1 (1)	268 (286)
Total (landings from areas predominated by category 4)	5—30	178	74 (70)	21 (23)	4 (5)	1 (2)	0 (0)	224 (241)
Dogger Bank	9—25	15	4 (10)	10 (15)	11 (15)	37 (30)	37 (30)	709 (536)
N. of Dogger Bank	22—40	26	3 (15)	11 (26)	17 (20)	48 (31)	21 (9)	664 (441)
Total (landings from areas predominated by large plaice)	9—40	41	4 (13)	10 (22)	14 (18)	43 (31)	29 (16)	684 (467)
Grand total	5—40	219	63 (62)	19 (23)	5 (7)	8 (6)	5 (3)	251 (260)

in which small plaice predominated consisted mostly of III-group and IV-group fish (the 1954 and 1953 year-classes). In landings dominated by large plaice the IV-group and the V-group were most abundant. Little remained of the strong predominance of the 1952 year-class, observed in 1956, when it dominated in 15 landings out of 18 examined. The predominance in 1956 of the IV-group in landings of small plaice as well as of landings of large plaice would tend to diminish the difference between these two groups of landings. On the other hand the age difference of about one year between the two groups in 1957 would tend to produce a more marked distinction between the groups. As mentioned above such a development was actually observed.

ERIK URSIN

Plaice and other Flatfish in the Skagerak-Kattegat Area

Coastal investigations, 0- and I-group (Table 21)

As usual the investigations were carried out by fishing from a motor-boat with the Johansen young-plaice trawl at 1—2 m. depth.

The average number of 0-group **plaice** on the northern part of the North Sea coast of Jutland was very much higher than in any of the few previous years when investigations were carried out on this coast. In the Nissum Broad it was over the mean for the previous years. On the Skagerak coast it was about the mean but in the northern and southern Kattegat it was 8 and 6 times the normal, respectively. In the central Kattegat it was twice the normal.

Table 21. Numbers of 0- and I-group plaice caught per hour with the Johansen young-plaice trawl on the Danish coasts in July 1957

Preliminary figures. Figures in brackets are means for 1905—1957.

Locality	Number of stations	Plaice 0-group	I-group
Nissum Broad (W. Limfjord)	9	457 —	58 —
Thyborøn-Hanstholm	5	122 —	4 —
Skagerak	17	56 (68)	32 (32)
N. Kattegat	15	839 (98)	21 (44)
C. Kattegat	13	48 (27)	1 (15)
S. Kattegat	11	180 (30)	0.2 (2)

The number of I-group plaice on the Skagerak coast was about normal but in Nissum Broad above the normal. In the northern Kattegat the number of I-group plaice was about half the normal and in the central and southern Kattegat this age-group was very scarce on the coast.

The density of the 0-group **flounder** was below the normal level on the Danish coasts of the Kattegat, where it is generally very poor. In the Laholm Bay and Skelderviken on the Swedish coast of the southern Kattegat, where the coastal investigations from the M/B "Havkatten" were allowed by courtesy of the Swedish Government, the density of the 0-group flounder was about normal.

The ca. 1-year-old **brill** was more than normally frequent in the central and southern Kattegat, which corresponds to the comparatively rich 0-group of this fish found here in 1956.

Turbot of the 0- and I-group were rare.

The 0-group **sole** was found in relatively great density on the Seeland coast. The numbers of the I-group sole were greater than normally on the Kattegat coasts, which corresponds to the good 1956 year-class, found in that year.

The stock of plaice in the Skagerak and Kattegat

Quantitative fishing with the standard trawl outside 6 m. depth (Table 22)

In the northermost Kattegat the age-groups II and III (the 1955 and 1954 year-classes respectively) dominated in the stock. The 1954 year-class was also rich in 1956. In November the number of

Table 22. Number of plaice caught per hour with the standard trawl in the northern Kattegat in 1957
Lengths to the nearest lower whole cm. Preliminary figures

Depth zone, m.	Number of stations	Age groups I	II	III	IV	V	Centimetre groups 11–15	16–20	21–25	26–30	31–35	36–40	Total
June													
6—14	4	97	184	32	3	0.5	52	208	44	13	—	—	317
15—24	6	13	41	15	5	0.3	3	34	29	8	0.3	—	74
25—34	2	8	19	9	3	—	5	11	18	5	—	—	39
November													
6—14	2	11	25	4	2	—	2	14	12	9	—	—	42
15—24	7	0.1	4	3	1	0.3	0.3	1	3	2	1	0.6	8
25—34	1	—	—	6	—	—	—	—	6	—	—	—	6
>35	6	—	0.7	1	1	—	—	—	1	1	1	—	3

Table 23. Length distribution and average length of plaice in Danish commercial catches from the Skagerak and Kattegat in 1957 in Danish seine and trawl
Lengths to nearest lower whole cm.

	Depth, m.	Number of samples	Length, cm. 26—27	28—30	31—35	36—40	41—45	Mean
Skagerak N. of Skagen								
1956, November	19—21	3	8	26	49	14	2	33.0
1957, November	13—21	2	10	24	47	17	2	32.8
Ca. 15 miles S.E. of Hals								
1956, October—November	12—15	4	36	37	21	6	0.3	29.7
1957, October—November	10—13	3	2	20	41	31	6	34.6
E. and N.E. of Fornæs								
1956, August—October	17—18	2	14	32	43	10	1	31.1
1957, August—October	16—19	3	14	28	45	10	5	32.4
Ca. 12 miles S.E. of Fornæs								
1956, September—November	18—21	4	13	25	40	21	1	32.2
1957, September—November	21—25	5	9	31	46	11	4	32.9
N.E. of Hjelm								
1956, August—November	17—24	4	6	22	55	17	—	33.1
1957, September—November	17—22	5	8	28	47	15	2	35.0

plaice of these year-classes was found to be seriously reduced; the density was at that time about one fifth of that in June. This reduction must be due partly to the season, because the plaice keeps more to the bottom, partly to the heavy fishing.

In the southernmost Kattegat quantitative fishing was carried out in October—November. Almost all the plaice caught were over 26.0 cm. long, and most of them belonged to the II-group.

Commercial catches of plaice in the Skagerak and Kattegat (Table 23)

The measurements show that north and south of the Scaw, in water of about 20 m. depth, the average length of plaice was 1—2 cm. lower in October—November 1957 than in the previous year. The decrease is explained by the facts that the older plaice in the catches (the 4- and 5-year-old fish) belonged to richer year-classes in 1956 than in 1957, and that the recruitment of the commercial plaice of 2 and 3 years old was stronger, being from richer year-classes, in 1957 than in 1956.

In the Aalborg bay shallows, in water of 10 to 15 m. depth, the average length of the plaice caught in October—November 1957 was 34.6 cm., against 29.7 cm. the year before. It may be assumed that this great increase in length is at least partly due to the recruitment in 1956 from the rich 1955 year-class, which reduced the average length of the commercial plaice more than did the recruitment in 1957 from the poorer 1956 year-class. In the late autumn of 1957 most of the plaice of the rich 1955 year-class must have reached a length well over the size-limit in this region, whereas in 1956 the corresponding age-group 1954 was much poorer here.

In the south-western Kattegat the average length of the commercial plaice in August—September 1957 was larger than in 1956. The cause of this increase is the same as in the central Kattegat, but here the difference is only a few cm. because the intensity of the fishery is greater here than in the central Kattegat.

Aage J. C. Jensen

Transplantion of Plaice to the Limfjord

As in 1956 it was not possible to carry out the transplantations from the Nissum Broad to the inner broads of the Limfjord to the planned extent.

It was intended to transplant 184,000 kg. but too small an immigration of young plaice to the Nissum Broad in connexion with rapidly rising water temperature stopped the work.

100,000 kg., corresponding to 1,454,000 specimens, were transplanted to the Thisted Broad and 28,000 kg., corresponding to 397,000 specimens, were transplanted to the Løgstør-Hannæs Broads. All the plaice were transported in well-smacks.

In comparison with the preceding years the examinations of the plaice for average length, weight, and age composition gave a rather different result:—

Year	Average length, cm.	Average weight, g.	Age composition, % I	II	III
1953	22.1	110	0	14	85
1954	19.5	72	0	85	14
1955	19.0	76	0	85—88	15—12
1956	19.0	75	3	82	15
1957	18.1	68	0	67	33

As shown above the average length and weight were smaller in 1957 than in the preceding four years in spite of the fact that the age-group III was represented with 33%.

A total of 3,870 plaice were tagged in the Limfjord, 500 with the Petersen disks, 2,690 with the roll-tag, and 680 with a subcutaneous tag. In the summer and autumn a further 1000 plaice have been tagged with the roll-tag in order to estimate the fishery mortality and the natural mortality.

In 1957 the costs of the transplantation to Thisted Broad was equivalent to the value of 28 tons of marketable plaice. According to fishery statistics 51 tons were caught until the end of this year, corresponding to a recapture percentage by weight of 51% (1956: 59%, 1955: 26%).

The transplantation to the Løgstør-Hannæs Broads was carried out in the last part of the transplantation period when the temperature was high. Accordingly the result has been unprofitable.

The tagging experiments in connexion with the transplantations have come to an end with the year 1957 and a report dealing with the results for the years 1953—57 will be published as soon as possible.

Ole Bagge

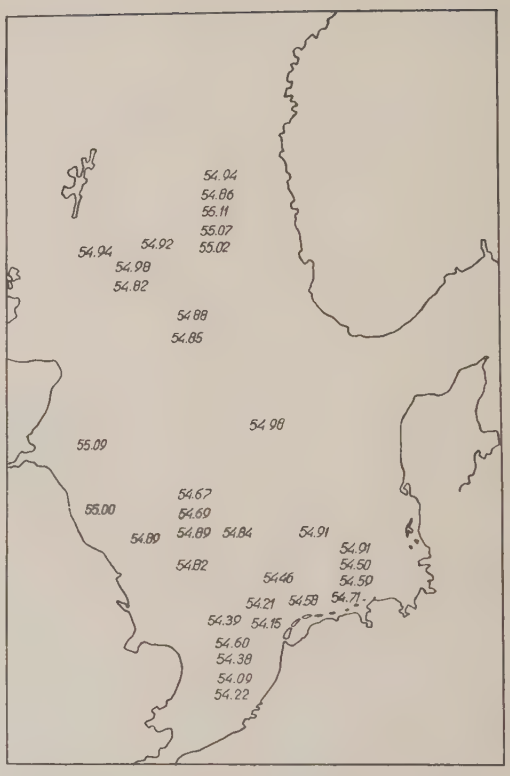


Figure 47. Average number of vertebrae in *Gadus merlangus*, in different areas of the North Sea. Number of whiting per sample, 50 specimens.

Whiting

Vertebral Counts in North Sea Whiting (*Gadus merlangus* L.) in 1957

(Figure 47)

To investigate whether different whiting populations occur within the North Sea, vertebrae counts are made regularly on whiting landed at IJmuiden, Holland. Although these counts render no decisive proof for the existence of separate populations, they may help to unravel the problem of the distribution of groups of whiting in the North Sea and of the intermingling of whiting from different areas.

The counts, the result of which is shown on the chart, have been made on samples of 50 specimens each, not analysing differences in vertebral number within the successive year-classes separately. However, judging from a number of special samples taken with the Dutch research vessel, the variance within one age-group was not smaller than the variance in a mixed-age sample. The data of the samples taken with the Dutch research vessel are incorporated in the figures on the chart. In 1957

the vertebrae of 1700 whitings were counted. The increasing number of vertebrae to the North tallies with the observations made by other investigators. Although there are no sharp boundaries, it seems possible to distinguish at least between a northerly and a southerly population, with mean vertebral numbers of 54.91 and 54.41.

M. Roessingh

Industrial Fisheries

German Sand-eel Investigations in 1957

(Tables 24–25)

The German sand-eel fishery has developed rapidly in recent years. Some landings, not yet statistically recorded, are indicated for the first time in 1952, 1953, and 1954 by the analyses of the fish-meal plants. There were at first very few landings only (1—3 analyses per year). They increased already in 1955 to such an extent, that one fish-meal plant carried out fat determinations from 46 sand-eel catches. Since 1956 the still further increasing landings are statistically recorded (Table 24).

In 1957 the fishery moved more and more into the south-western part of the North Sea. From the middle of May until the 1st of July nine samples, including 4,015 sand-eels weighing 70 kg., were taken from catches brought in from the fishing grounds of Terschelling to Borkum Riff. The by-catch of other fish amounted only to 0.55 kg., e.g., 0.8% in these samples. This means that very few other fish are taken by the sand-eel fishery.

The average lengths of sand-eels sampled were approximately 17.5 cm. The catches consisted nearly exclusively of *Ammodytes lancea marinus* Raitt. In a sample from Terschelling only 2 specimens of *Ammodytes immaculates* were found among 101 sand-eels, which species was not discovered until 1950 by Corbin. Supplementary investigations on sand-eel from shrimp catches showed that the species *Ammodytes lancea lancea* (Jarrel) occurs nearly exclusively in the offshore area of the Elbe estuary.

A sample taken at the beginning of December 1957, consisted exclusively of that species. 72 sand-eels selected from shrimp catches in summer included 66 *A. lancea lancea*, 5 *A. l. marinus* and 2 *Hyperoplus lanceolatus* (Lesauvage) (juvenile specimens).

The investigations on the fishery itself and on the species caught were supplemented by investigations on the condition of the sand-eel. The fat content of the subspecies *A. l. marinus* reached in April 6% as indicated by the analyses made by the fish-meal plants. Up to the end of the fishing season (July) it seldom rose to 7%. The coastal form *Ammodytes lancea lancea* was still lean (2.6% fat) at the end of April, but its fat content rose to about 6% towards the end of May. In one year only (1954) out of the last five years fat content as high as 12% has been recorded according to the commercial analyses.

Dry matter and fat content are closely correlated in the sand-eel, and its content of fat-free dry matter (21.4%) is greater than in the herring (19.5%). The ash content amounts to approximately 3%. The gonads of the male sand-eel have a low fat content and a relatively high ash content, whereas the reverse holds good for the female gonads (Table 25).

P. F. Meyer-Waarden

Table 24. Sand-eel landings from German cutters (in tons)

	March	April	May	June	July	Total
1956	—	83	1,046	2,138	2,030	5,297
1957	294	1,686	7,014	11,836	4,675	25,505

Table 25. Content of fat and ash in approximately ripe gonads of the sand-eel

	Fat	Ash	(% of the fresh substance)
Male	1.2	2.5	
Female ...	10.1	1.3	

References

Kühl, H., 1957: "Die deutsche Fischerei auf Industriefische in der Nordsee im Jahre 1957." Arch. Fischereiwiss., **8** (3).

Lühmann, M., 1957: "Über jahreszeitliche Veränderungen des Fettgehaltes und des Gehaltes an Trockensubstanz und Asche bei Sandspierlingen (*Ammodytes* spec.)". Ibid., **8** (3).

Undersized Food Fish in the German Landings of Industrial Fish

(Tables 26–29)

In recent years the industrial fishery has also been engaged in sand-eel fishing. The sand-eel landings increased extremely rapidly and reached 25,500 tons in 1957. This type of fishery must be carried out with small-meshed nets. There is, however, no evidence that this fishery leads to the destruction of a significant number of undersized food fishes protected by the 1946 Convention. Examination of the sand-eel catches in general revealed that very few other species were taken. Twelve random samples taken from the catches contained only 0.8% of other species. The species

caught together with the sand-eel were predominantly herring, sprat, and horse mackerel, occasionally whiting, dab, and some octopus. There are no earlier German investigations on the composition of sand-eel catches. The "industrial" herring (for fish-oil production) caught by German cutters in the S.E. North Sea in 1957 also contained only a small proportion of undersized protected fish. This share, expressed in weight, amounted to 2.1% in June, 1.6% in August, and as little as 0.4% in September. In 1956 the corresponding figures were 8.1, 4.0, and 8.1%. The proportion of undersized food fish in the industrial herring catches did evidently decrease considerably. This decrease is mainly due to the fact, that the greatest part of the abundant 1955 year-class of whiting in the meantime has grown to exceed the size-limit of 20 cm. The same holds good for haddock; already in October 1956 the maximum length of the haddock caught in addition had almost reached the 27 cm. limit; in July 1957, at the beginning of the industrial herring season, it approached 29 to 32 cm.

The industrial herring catches have been thoroughly investigated since 1953. The yield of this fishery fluctuates considerably from year to year (Table 26).

Table 26. Annual yield of the German oil herring fishery

Year	1951	1952	1953	1954	1955	1956	1957
Quantity in tons	7,204	13,712	26,028	38,774	48,670	22,074	17,030

There are also variations in the proportions of the by-catch. Apart from sprats, the quantities of whiting, haddock, and other species contained in the herring landings are shown in Table 27.

Table 27. Proportion of whiting, haddock, and other species (sprat excepted) in the oil herring landings

Year	Whiting		Haddock		Other species	
	No. %	Weight %	No. %	Weight %	No. %	Weight %
1953	3.7	4.2	1.0	2.8	0.4	0.4
1954	3.2	5.1	0.5	1.8	0.5	1.4
1955	4.2	7.0	0.2	1.2	1.0	1.7
1956	6.0	7.3	1.4	4.1	2.6	3.4
1957	9.5	14.8	0.6	2.7	3.1	5.0

For the North Sea Convention the by-catch of undersized whiting and haddock is of particular interest. The percentage of undersized whiting and haddock in the total landings can be derived from Table 28.

Table 28. Proportion of undersized whiting and haddock in the German oil herring landings

Year	Whiting under 20 cm. Weight %	Haddock under 27 cm. Weight %
1953	0.8	0.9
1954	0.5	0.8
1955	0.9	0.1
1956	3.2	2.9
1957	0.5	0.0

The ratio of undersized specimens to the total number or the total weight of whiting and haddock caught by the oil herring fishery (Table 29) varies extremely from year to year. This is particularly striking with regard to the by-catch of whiting in 1956 and 1957. In 1956 most individuals of the extremely abundant 1955 year-class were below the minimum size; in 1957 this strong year-class had exceeded the 20 cm. limit. Similar conditions have been found for haddock.

Table 29. Ratio of undersized whiting and haddock to total catch of these species

Year	Whiting		Haddock	
	No. %	Weight %	No. %	Weight %
1953	38.2	20.4	46.2	33.0
1954	10.2	4.9	43.8	15.1
1955	27.2	8.0	15.8	7.4
1956	65.0	31.3	(76.6)[1]	(62.5)[1]
1957	8.1	3.1	(2.1)[2]	(1.0)[2]

[1]) Yearly average computed from the monthly averages.
[2]) From July landings only; no undersized haddock had been found in August and September.

In order to complete the measurements whiting and haddock have specially been sampled from the 1957 catches.

Apart from whiting, haddock, and sprat, the 1957 by-catch consisted mainly of horse mackerel, dab, and gurnard. Plaice, megrim, and dragonet occurred only in small quantities, and only few large specimens of cod were recorded.

P. F. Meyer-Waarden

Undersized Protected Fish Species in the German Shrimp Catches

Shrimping is the most important activity of Germany's coastal fishery in the North Sea. Owing to the small size of the shrimp it is, of course, necessary to use narrow-meshed nets for that type of fishery. As the shrimp fishing grounds are often at the same time nursery grounds for some food fish species, the shrimp catches do unavoidably include certain quantities of undersized protected

food fish. The frequently worded apprehension, that various species of food fish suffer substantial losses through the activities of the shrimpers, may, however, scarcely be maintained.

Since 1954, the following approximate amounts of undersized food fish have been caught by the German shrimp fishery, according to investigations carried out by the Hamburg Institut für Küsten- und Binnenfischerei:—

	1957	1956	1955	1954	
Plaice	1166	805	1084	1086	tons
Dab	95	279	503	418	,,
Sole	364	322	610	419	,,
Whiting	234	301	58	65	,,
Cod	155	23	58	16	,,

In the same years the quantities of shrimp caught were as follows:—

1957	1956	1955	1954
43,900	38,200	52,700	40,500 tons

Even if we substract the amount of about 5,000 tons of larger shrimp used annually for human consumption, the percentage of undersized food fish in the shrimp landings for industrial purposes is relatively small, viz. about 5.2% during the years of investigation (1957—1954), or 5.4%; 5.3%; 4.9%; and 5.6% respectively. As a rule, the catches also included fairly large amounts of crabs (*Carcinus maenas* and *Portunus holsatus*), i.e., 3.9% on the average from 1957 to 1954. The proportion of species of fish not protected by the London Convention was slightly greater; i.e., 7.6%; 6.0%; 5.2%; and 5.4% respectively in the years concerned, which amounts to 6.1% on the average. Considerable amounts of gobies (1.6%), armed bullheads (0.6%), sea snails (0.6%), and sea scorpions (0.5%) are usually found in the catches. Smelt and young herring occur in fluctuating numbers among the shrimps, but on some fishing grounds smelts are regularly caught in larger quantities (1.2%).

The variations in the by-catch of the shrimp fishery during the various years depend mainly on variations in the strength of the respective year-classes. In general, the quantities of undersized protected fishes observed in the landings of the shrimp fishermen give no reason for serious concern.

P. F. Meyer-Waarden

Rare Fishes from Near Northern Seas

Scotland

The following rare fishes were recorded in Scotland in 1957:—

Scymnorhinus licha (Bonnaterre)—2: Moray Firth, III; N. Minch, X.

Squatina squatina (L.)—6: Aberdeenshire coast, IV, VI, VII; Butt of Lewis, V; Turbot Bank, X; Cape Wrath, XI.

Torpedo nobiliana Bonaparte—5: Moray Firth, IV, IX; 43′ S.$^1/_2$E. Aberdeen, VI; Montrose Bay, VIII; W. Orkney, XII.

Myliobatis aquila (L.)—1: Outer Moray Firth, XII.

Acipenser sturio L.—6: Moray Firth, I; 45′ E. Aberdeen, I; E. Firth of Forth, II; N. Minch, III; Shetland, X; Buchan Ness, X.

Alosa alosa (L.)—2: Moray Firth, IV; Aberdeen Beach, VII.

Alosa finta (Cuvier)—11: Moray Firth, I (2), II (2); Firth of Forth, I, III (2), XII; 70′ E.×N. Peterhead, II; Fraserburgh, III; 45′ S. Aberdeen, IV.

Sardina pilchardus (Walbaum)—2: Outer Hebrides, VI; N. Minch, VIII.

Engraulis encrasicholus (L.)—2: 58°17′N.—1°20′E., XI (2).

Scomberesox saurus (Walbaum)—4: Shetland II; St. Kilda, IX (2); Buchan Ness, XI.

Belone belone (L.)—several: 220′ to 240′ N.E.×E. Aberdeen, IV (several); 57°30′N.—0°20′W., XI (5 young); 56°30′N.—0°40′W., XI (2 young).

Lampris guttatus (Brünnich)—1: Shetland, VIII.

Beryx decadactylus Cuvier & Valenciennes—8: W. St. Kilda, VI.

Morone labrax (L.)—2: Moray Firth, I, XII.

Naucrates ductor (L.)—1: N. Minch, X.

Brama raii (Bloch)—21: Moray Firth, I; N. Minch, I; Geo. Bligh Bank, VII (2); Lousy Bank, VIII (3); Faroe Bank, IX; Aberdeen Bank, X; N. Minch, X (2); Firth of Forth, X (2); off Fraserburgh, XI; 200′ E.S.E. Aberdeen, XI; Aberdeenshire coast, XI; Tod Head, XI; 180′ E.N.E. Aberdeen, XII; Moray Firth, XII; Johnshaven, XII (2).

Mullus surmuletus L.—11: Aberdeenshire coast, I, II (3); Shetland, II, III; 40′ S.S.E. Aberdeen, V; Moray Firth, VII, X; St. Abbs, XI; Turbot Bank, XII.

Spondyliosoma cantharus (Gmelin)—5; Aberdeenshire coast, I (2), II, VIII; Cape Wrath, XII.

Aphanopus carbo Lowe—4: W. Butt of Lewis, VI; Geo. Bligh Bank, VII (3).

Centrolophus niger (Gmelin)—2: W. Barra Head, V; Moray Firth, XI.

Mugil chelo Cuvier—3: Broad Bay, Lewis, VIII; Shetland, IX, X.

Mola mola L.—2: N. Minch, VII; Lousy Bank, VIII.

B. B. Rae, J. M. Lamont

Germany

The Institut für Seefischerei der Bundesforschungsanstalt für Fischerei, Hamburg, received in 1957 the following remarkable species from Near Northern Seas:—

Artediellus atlanticus Jordan & Evermann 1898 caught by F.R.S. "Anton Dohrn", 28. January 1957; 57°32.5'N.—7°00'E.; 210 m. depth; 1 ♀, 57 mm. in total length;
caught by F.R.S. "Anton Dohrn", 29. January 1957; 57°44'N.—5°47'E.; 150 m. depth; 2 ♂♂, 68 + 70 mm. in total length.

Maurolicus müllerí (Gmelin 1789) caught by F.R.S. "Anton Dohrn", 29. January 1957; 57°45'N.—5°55'E.; 220 m. depth; 5, 5—7 cm. in total length.

Somniosus microcephalus (Bloch & Schneider 1801) caught by F.R.S. "Anton Dohrn", 17. January 1957; 57°55'N.—10°49.5'E.; 155 m. depth; 1 ♂, 206 cm. in total length.

Myliobatis aquila (Linnaeus 1758) caught by F.V. "Düsseldorf", 22. November 1957; off the French side of the Channel; 1 ♀, 140 cm. in total length (reported by Dr. H. Kühl, Cuxhaven).

G. Krefft

Baltic-Belt Seas

INTRODUCTION

Contributions have been received from:—

Denmark:
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A. Environment

The bottom salinity at the "Halsskov Rev" lightvessel to the east of the island of Sprogø in Great Belt was higher than normal in February and July—September and below normal, especially in November.

The maximum in July—September was also found at the German lightvessels in the western Baltic, but, on the whole, the bottom salinities were comparatively low here in 1957.

The November minimum was also observed at the surface at "Halsskov Rev" and "Gedser Rev" lightvessel.

At Christiansø to the north-east of Bornholm and at the Swedish lightvessels from the southern Scania to the north of Stockholm the surface salinity was above normal throughout the year. In the northernmost Baltic (the "Sydostbrotten" lightvessel) it was about normal.

At the entrance of the Sound between Copenhagen and Malmö ("Oscarsgrundet" lightvessel) the monthly mean salinities at the bottom show that inflows from the Kattegat occurred especially in January, May, August, and December. The first were not strong enough to give a renewal of the bottom layer in the central Baltic. Inflows in the late autumn of 1956 and January 1957 had given a small renewal of the bottom layers of the Bornholm Basin, but in the Landsort Deep and west of Gothland the oxygen content was very low in April 1957.

The surface temperatures were relatively high in February—April in the Belts and the southern parts of the Baltic. In the western Baltic they were also high in July—August but, for the rest, the monthly means were mostly about or below normal. In the central and northern Baltic the water was covered with ice in the spring months and here low temperatures prevailed the whole year through.

The bottom temperatures in the Great Belt were above normal in February—April and in November, and below normal in the other months. At the Swedish lightvessels the variations of the bottom temperatures were very different from one place to another, and a general trend cannot be seen.

Filarski's continued investigations show that a small renewal of the bottom water in the Bornholm Deep occurred in January 1957.

At Bornholm phytoplankton was unusually abundant in May and the fat content in summer was very much higher than in the cold summer of 1956; in summer and autumn it was, on the whole, higher than normal. Correspondingly the fat content of the herring was good.

In the central Baltic and the Gulf of Riga the amount of zooplankton was investigated regularly until October by USSR. An unusually great amount of zooplankton was observed in April—June. Nikolaev explains this as a consequence mainly of an extraordinarily great production of phytoplankton in early spring, caused by a very heavy discharge from the rivers during January—March and a great intensity of light. But Nikolaev assumes that the great amount of planktonic crustaceans in April—June is partially due to a comparatively small amount being eaten by fish on account of the low temperature of the water. From August to October the amount of plankton was only a little above normal, and Nikolaev ascribes this to a relatively small development of *Cladocera* and to an intensive feeding of pelagic fishes.

B. The Fish

The eggs taken at the "Fehmarnbelt" lightvessel in the period December 1956—August 1957 were very much fewer than normal, except those of mackerel which were more frequent than in any of the previous years. According to KÄNDLER it is doubtful whether the occurrence of pelagic eggs in the Fehmarnbelt is illustrative of the spawning intensity for the whole area. On a cruise at the end of June mackerel eggs were found in fairly large quantities in Kiel Bay and southern Great Belt but they were very scarce in northern Great Belt and the Little Belt. The opposite can be said about the occurrence of sprat eggs. A few anchovy eggs were observed to the north of Fyn where many were found in 1956.

The amount of 0-group plaice present in the coastal area of the Belts seems to have been about normal, but in the western Baltic this group was more plentiful than normal, and even more so than in the Belts, which is very unusual. In the Sound a displacement to the south of the frequency of 0-group plaice was also observed. The abnormal distribution may seem to be attributable to the strong inflow of salt water in February. From the temperature and salinity data we might have expected the strength of the 1957 year-class to be below normal, but the large stock of spawning fish found in these waters after the war seems to have had a beneficial effect on the propagation of the stock. The origin to the large stock is the restricted fishery during the war years.

At Bornholm the density of 0-group plaice along the coasts was below normal in accordance with the low water temperature during the spring.

In the open sea of the Belts the II-group plaice (the very rich 1955 year-class) predominates.

In the western Baltic the occurrence of plaice was relatively sparse and the catches were mostly composed of older and larger fish, as confirmed by the Danish and German investigations.

In the Sound, where trawls and seines are prohibited, the stock was larger and the length and age of the plaice was as usual considerably greater than in the Belts.

Dab is far more numerous than plaice in the Belts and the western Baltic, although the density has decreased since 1955 when small dab of the 1954 year-class were abundant. Danish trawl hauls with the standard trawl showed a length of the dab in the northern Belts of less than 24 cm., in the western Baltic, however, 15—25% from Danish and German hauls were more than 24 cm. In the Sound the majority were over the Danish size limit of 25 cm. In the Baltic proper, at Møen, and at Bornholm the dab were as sparse as the plaice.

KÄNDLER reports that flounder were scarce in the western Baltic. There they are mostly encountered at dephts lower than those in which the Danish fishery with the standard trawl is operated. In the Baltic proper where the Swedish experimental trawlings are carried out in June at dephts between 47 and 49 m. only few flounder were caught east of Bornholm, but between Bornholm and Gothland at depths of 60—90 metres flounder was the predominant flatfish present — or the only one of these species. OTTERLIND and SELLERBERG call attention to the considerable seasonal variations in the distribution of flatfish.

From the German quantitative fishery it appears that in the western Baltic the cod is by far the most abundant species of the commercial fish caught with trawls.

The Danish prediction of the silver-eel fishery failed in 1957. The tumour disease was about as frequent as in the preceding years.

BORISOV reports on the nightly migrations of the eel.

AAGE J. C. JENSEN

ENVIRONMENT

Hydrography

Danish Observations in the Great Belt and the Western Baltic

(Tables 1–3)

At the lightvessels "Halsskov Rev" and "Gedser Rev" the salinity varied round the normal, the most conspicuous feature common to both localities being the low salinities, recorded in November.

The temperatures were low in September—October, but during the rest of the year generally slightly above normal.

HELGE THOMSEN

Table 1. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Halsskov Rev" for a longer series of years, and deviations from these means
(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					**Surface**							
Mean	16.8	14.8	13.4	13.9	13.0	14.3	13.9	14.4	14.6	16.2	16.3	15.6
Deviation 1957	–0.7	2.1	0.1	0.0	0.3	–0.5	–0.5	–0.2	2.4	1.0	–2.4	0.3
					Bottom							
Mean	21.9	21.7	24.5	27.6	29.7	30.3	29.4	27.6	24.7	23.3	21.5	22.1
Deviation 1957	–1.4	3.9	0.2	1.2	–3.4	0.7	1.8	2.1	3.4	–2.9	–3.4	–3.1
Temperature					**Surface**							
Mean	2.4	2.0	2.4	4.5	8.9	12.7	15.7	16.4	14.5	11.1	7.3	4.0
Deviation 1957	–0.2	0.6	0.3	1.1	0.1	1.3	2.2	0.6	–0.7	–0.3	1.1	0.3
					Bottom							
Mean	3.9	3.4	3.4	4.3	5.7	7.1	9.1	11.7	13.2	11.6	8.4	5.9
Deviation 1957	–0.7	0.7	0.8	0.4	0.8	–0.7	–1.2	–1.0	–1.3	–0.4	0.8	–0.4

Table 2. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Gedser Rev" for a series of years, and deviations from these means
(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					**Surface**							
Mean	12.1	11.4	10.2	9.7	8.8	9.1	9.1	9.7	9.8	10.2	11.9	11.9
Deviation 1957	0.0	0.3	–1.1	–0.7	0.1	0.3	–0.6	–0.2	1.2	1.1	–1.8	–0.4
					Bottom (15 m.)							
Mean 15 m.	13.9	12.7	13.8	13.1	12.9	13.4	12.6	11.9	12.4	12.6	12.2	13.1
Deviation 1957	–0.9	–0.4	–3.2	–0.4	–0.3	–0.8	0.2	0.9	0.4	0.4	–1.5	–1.0
Temperature					**Surface**							
Mean	2.2	1.5	2.1	4.1	8.0	12.6	15.8	16.1	14.3	11.1	7.6	4.3
Deviation 1957	0.2	0.9	0.7	0.9	0.2	0.6	1.6	0.4	–0.5	–0.3	0.8	0.4
					Bottom (15 m.)							
Mean 15 m.	2.8	2.2	2.2	3.6	6.3	10.1	13.1	14.4	14.0	11.8	7.9	4.8
Deviation 1957	–0.2	0.2	0.6	0.9	0.9	1.1	0.5	0.8	0.0	–0.7	0.8	0.1

Table 3. Monthly means of salinity and temperature at Christiansø for a longer series of years, and deviations from these means
(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity												
Mean	7.0	7.0	7.0	7.0	7.0	7.2	7.4	7.2	7.0	7.0	7.1	7.0
Deviation 1957	1.5	1.5	0.9	1.0	1.0	0.7	0.5	0.6	0.8	0.6	0.6	0.9
Temperature												
Mean	3.3	2.1	1.8	3.0	6.1	11.0	15.2	16.0	14.1	11.1	8.1	5.5
Deviation 1957	0.3	1.2	0.9	0.6	0.0	0.2	1.2	0.9	–1.5	–0.7	0.3	–0.1

German Observations of the Hydrographic Conditions in the Western Baltic in 1957

(Table 4)

Daily surface observations (8h MET) of temperature and salinity have been made at 3 German lightvessels in 1957 according to the routine commenced in 1949. The positions are:— "Fehmarnbelt" (54°36.0′ N., 11°09.0′ E.); "Kiel" (54°29.5′ N., 10°17.3′ E.); and "Flensburg" (54°50.3′ N., 9°53.8′ E.). The data will be published in full in a yearbook entitled "Meereskundliche Beobachtungen und Ergebnisse". Monthly means of the observations are given in Table 4 in comparison with the means for the years 1950/54. Subsurface hydrographical observations were made daily at "Fehmarnbelt" lightship only.

The observations made at the "Fehmarnbelt" are representative of regions in which both ingoing and out-going currents occur; the observations at "Kiel" and "Flensburg" lightships illustrate the conditions in the regions of the Baltic in which there is no strong current.

Surface salinity in 1957 was generally lower with the exception of February, May, and June, in comparison with the five-year means.

Surface temperatures were comparatively high from February to April, comparatively low in May, September, and December, and about normal in the other months compared with means for the period 1950/54.

The bottom temperature from February to June was high and from September to January low, compared with the means for 1950/54, while the salinity values were high from July to September only. The annual mean shows a value nearly $2^0/_{00}$ lower than the five-year mean (see Table 4).

According to the five-year means the annual means of temperature are too high and the annual means of salinity too low (see Table 4).

G. Koopmann

Table 4. Monthly means of temperature and salinity at surface and bottom, for the period 1950/54 and for 1957, at the German lightvessels "Flensburg", "Kiel", and "Fehmarnbelt"

(From Deutsches Hydrographisches Institut, Hamburg)

Month		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Salinity														
						Surface								
"Flensburg"	1950/54	19.8	18.3	17.4	17.4	14.8	15.2	16.9	17.6	18.8	19.2	18.4	19.9	17.8
	1957	18.7	18.5	16.2	15.4	15.7	15.2	15.2	16.3	18.0	19.6	18.4	(18.0)	17.1
						Surface								
"Kiel"	1950/54	19.2	17.9	17.1	16.4	13.8	13.6	14.8	15.7	16.5	18.7	18.6	19.5	16.8
	1957	17.8	18.1	16.7	15.0	14.5	14.4	13.4	14.6	16.7	17.7	17.9	16.3	16.1
						Surface								
"Fehmarnbelt" ...	1950/54	15.4	13.5	13.5	13.0	10.3	11.7	13.2	12.1	15.4	14.8	14.5	16.4	13.6
	1957	15.0	14.6	11.5	11.6	12.0	12.2	11.4	12.7	15.1	15.0	12.2	14.4	13.2
						Bottom								
	1950/54	21.2	21.1	22.0	24.5	26.5	27.7	28.5	27.0	25.4	22.7	21.2	21.6	24.1
	1957	17.9	20.2	19.4	24.1	22.7	26.6	29.0	27.8	25.9	19.9	18.0	16.3	22.3
Temperature														
						Surface								
"Flensburg"	1950/54	2.9	1.2	1.9	4.9	10.5	14.1	15.5	16.3	14.4	11.5	7.9	5.3	8.9
	1957	2.5	2.8	2.9	5.9	9.0	14.3	17.8	16.5	13.6	11.0	8.1	4.8	9.1
						Surface								
"Kiel"	1950/54	2.7	1.1	1.9	5.1	10.0	14.3	16.5	16.7	15.0	11.7	8.4	5.1	9.0
	1957	2.8	3.0	3.3	6.2	9.2	13.9	18.2	16.9	14.0	11.2	8.8	4.4	9.3
						Surface								
"Fehmarnbelt" ...	1950/54	2.9	1.3	2.0	5.3	9.4	14.2	16.4	16.7	15.1	11.7	8.4	5.3	9.1
	1957	2.6	2.8	3.1	5.7	9.1	14.4	18.2	17.2	14.2	11.4	8.8	5.0	9.4
						Bottom								
	1950/54	4.2	2.4	2.8	4.0	5.3	7.0	9.0	10.5	12.6	11.9	9.7	6.2	7.1
	1957	2.9	3.2	3.6	4.6	6.2	7.3	8.0	8.9	10.7	11.4	9.6	5.3	6.8

Swedish Observations

(Tables 5 and 6)

The monthly means of temperature in 1957 at the lightvessels in the Baltic are fairly normal (see Table 5). A deficit occurs during the last months, especially in October. In the Bothnian Sea the thermocline in August remained at such a low level that the temperature at a depth of 30 m. at "Finngrundet" shows a remarkably high deviation of +5.3°.

Any marked change in salinity did not occur in 1957. In June the bottom water at "Sydostbrotten" was characterized by an unusually high salinity of 6.10 ‰.

Data from the deep basins of the Baltic collected in April and September (see Table 6) do not indicate any inflow of salt water. The consumption of oxygen in the deep strata is continued.

N. Jerlov

Table 5. Monthly means of salinity and temperature in 1957 at surface and bottom at Swedish lightships with the deviations from 30–year means

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					**Surface**							
"Sydostbrotten"	—	—	—	—	—	4.44	4.22	3.98	5.05	5.30	5.12	5.49
Deviation	—	—	—	—	—	−0.2	−0.1	−0.3	+0.5	+0.4	−0.1	+0.2
"Finngrundet"	5.72	—	—	—	—	5.89	5.84	5.67	5.52	5.75	5.66	5.78
Deviation	+0.3	—	—	—	—	+0.4	+0.4	+0.4	+0.3	+0.4	+0.3	+0.5
"Svenska Björn"....	6.33	6.43	6.35	—	6.53	6.06	5.88	6.08	6.12	6.42	6.24	6.57
Deviation	+0.1	+0.2	+0.2	—	+0.6	+0.4	+0.3	+0.6	+0.5	+0.5	+0.1	+0.4
"Falsterborev"	8.72	9.08	8.25	7.94	7.87	7.86	8.34	8.36	8.53	8.68	8.43	8.68
Deviation	+0.5	+1.0	+0.5	+0.4	+0.4	+0.3	+0.5	+0.4	+0.6	+0.3	+0.2	+0.4
"Oskarsgrundet"....	14.08	9.92	9.27	10.23	8.65	8.49	9.98	10.90	10.07	10.85	9.09	12.67
Deviation	+3.0	−1.3	−0.9	+0.8	+0.2	−1.4	+0.1	+1.3	−0.7	−0.9	−1.4	+0.7
					Bottom							
"Sydostbrotten"	—	—	—	—	—	6.10	6.14	6.16	5.72	6.28	5.78	5.64
Deviation.	—	—	—	—	—	+1.5	+0.5	+0.5	+0.1	+0.7	+0.2	+0.1
"Finngrundet"	5.72	—	—	—	—	5.92	5.88	5.81	5.75	5.74	5.70	5.80
Deviation	±0	—	—	—	—	+0.2	+0.1	+0.1	±0	±0	+0.1	+0.1
"Svenska Björn"....	6.66	6.96	6.86	—	7.09	7.09	6.98	6.92	6.99	6.86	7.09	6.68
Deviation	−0.2	+0.3	+0.1	—	+0.3	−0.3	−0.3	−0.8	−0.3	−0.5	+0.2	−0.1
"Falsterborev"	9.05	9.12	8.26	7.93	7.84	7.89	8.30	8.44	8.67	8.78	8.45	8.68
Deviation	+0.6	+0.8	+0.5	+0.3	+0.4	+0.3	+0.2	+0.3	+0.5	+0.1	+0.1	+0.2
"Oskarsgrundet"....	14.98	10.00	10.78	10.67	15.00	12.68	11.13	12.60	10.10	10.95	9.13	17.33
Deviation	+1.4	−3.8	−2.8	−1.8	+5.2	+0.5	−0.3	+1.8	−2.6	−3.0	−5.0	+2.8
Temperature					**Surface**							
"Sydostbrotten"	—	—	—	—	—	7.5	13.4	15.0	12.1	6.8	4.3	2.3
Deviation	—	—	—	—	—	−0.9	−0.7	−0.4	+0.2	−0.9	−0.5	−0.9
"Finngrundet"	0.8	—	—	—	—	6.2	13.3	14.2	—	6.5	5.6	—
Deviation	−0.8	—	—	—	—	−1.1	−0.5	−1.4	—	−1.5	+0.5	—
"Svenska Björn"....	1.3	0.8	—	—	3.3	8.1	14.7	15.1	11.8	7.4	5.9	3.8
Deviation	−1.1	−0.4	—	—	−0.9	−0.8	±0	−0.7	−1.3	−1.6	−0.7	−0.5
"Falsterborev"	2.7	2.4	2.5	4.0	7.2	12.9	16.6	15.6	12.5	10.3	7.8	4.9
Deviation	−0.2	+0.6	+0.5	+0.3	−0.6	+0.5	+0.8	−0.9	−2.2	−1.4	−0.6	−0.2
"Oskarsgrundet"....	2.7	2.6	2.6	4.8	8.0	13.5	17.6	16.2	13.2	10.3	8.4	4.5
Deviation	−0.1	+0.7	+0.4	+0.5	−0.4	+0.4	+1.5	−0.5	−1.6	−1.1	+0.4	−0.2
					Bottom							
"Sydostbrotten"	—	—	—	—	—	1.4	1.5	1.9	—	3.9	4.9	3.1
Deviation	—	—	—	—	—	−0.6	−0.9	−1.3	—	−2.2	±0	−0.8
"Finngrundet"	1.0	—	—	—	—	4.2	4.8	10.6	—	6.0	5.6	—
Deviation	−0.6	—	—	—	—	−0.3	−0.4	+5.3	—	−0.5	−0.5	—
"Svenska Björn"....	2.3	1.7	—	—	2.2	3.1	3.6	4.5	5.6	6.2	5.6	4.3
Deviation	−0.4	+0.1	—	—	−0.2	−0.1	−0.2	−0.8	±0	−0.1	−0.5	−0.3
"Falsterborev"	2.7	2.4	2.5	3.9	7.3	12.3	15.4	15.1	12.4	10.3	7.8	4.9
Deviation	−0.2	+0.6	+0.5	+0.3	−0.2	+0.5	+0.8	−0.6	−2.2	−1.4	−0.6	−0.2
"Oskarsgrundet"....	2.9	3.0	2.7	4.7	7.6	12.9	17.5	16.0	13.2	10.4	8.6	5.7
Deviation	−0.5	+0.6	+0.2	+0.4	−0.5	+0.4	+1.7	−0.5	−1.5	−1.1	+0.2	+0.4

Table 6. Swedish hydrographic measurements in the deep basins of the Baltic

Bornholm Deep

55°25′N., 15°40′E. 9. April				55°15′N., 15°59′E. 19. September		
m.	°C.	‰	O_2	m.	°C.	‰
0	3.42	7.91	—	0	13.60	7.49
10	3.41	7.91	9.29	20	13.56	7.52
20	3.28	7.92	9.34	30	12.74	7.44
40	2.82	8.00	9.01	40	4.58	7.87
58	3.41	8.86	7.93	55	4.23	9.90
87	5.18	15.98	2.57	65	5.96	12.74
				85	5.44	15.24

Landsort Deep

58°35′N., 18°15′E. 24. April				4. September		
m.	°C.	‰	O_2	m.	°C.	‰
0	2.03	6.75	—	0	15.26	6.61
10	1.96	6.81	11.13	20	14.77	6.65
40	1.48	7.32	9.35	50	3.39	7.58
70	3.91	9.37	2.66	80	4.06	9.95
100	4.55	10.53	1.06	100	4.47	10.66
150	4.68	10.91	0.81	200	4.70	11.07
440	4.97	11.25	0.48	300	4.86	11.15
				450	4.97	11.21

Gothland Deep

57°20′N., 19°58′E. 10. April			
m.	°C.	‰	O_2
0	2.40	7.63	—
10	2.42	7.63	9.06
40	2.46	7.64	9.15
60	2.50	7.64	9.18
80	4.21	10.03	2.12
230	5.74	12.73	0

W. Gothland

58°00′N., 18°00′E. 25. April				3. September		
m.	°C.	‰	O_2	m.	°C.	‰
0	1.97	7.13	—	0	15.58	6.39
10	1.95	7.13	9.46	20	15.57	6.42
40	1.53	7.18	9.36	40	3.40	7.18
70	3.86	9.70	2.79	70	4.02	9.68
125	4.55	10.62	0.76	80	4.40	10.39
185	4.72	10.78	0.47	110	4.63	10.73

Polish Observations in the Southern Baltic during 1956—1957

(Figures 1–2)

The 306 hydrographic stations worked in the southern Baltic in 1956—57 were continuation of others worked in former years.

The results indicate a further decline in the salinity of the water layers near the bottom of Gdansk and Bornholm Deeps.

In the region of Arkona which is an area of heavy water flow, no remarkable inflow of high-salinity water could be observed during the period concerned.

A salinity exceeding 8‰ was maintained in the surface waters in the period November 1956 to May 1957. The salinity of the water layers near the bottom oscillated between 14.65 and 9.98‰. In one case only, and at one station only, situated in the western part of the basin, did the salinity rise to 19.34‰ in March 1956 (on 10. March) at a water temperature of +0.5°C. It may be concluded that this occurred in an isolated hollow in the sea-bed. The minimum winter temperature of the water of –0.3°C. was also noted in March 1956. (Station A).

In Bornholm Deep the salinity of the water ayers near the bottom decreased systematically from 16.2‰ in 1956 to a minimum of 14.98‰ in November 1957.

The changes in the isohalines and isotherms, all of which were observed in January 1957 atStation B_1 situated in Bornholm Deep (Fig. 1a and b) and particularly the rapid increase in the oxygen content of the water layers near the bottom (80—95 m.), allow us to conclude that the water in this region was renewed.

However, the transient character of these changes shows that the inflow was not of any considerable magnitude. The temperatures of the water layers near the bottom oscillated between 5 and 6°C. and a minimum of 4.8°C. was observed only in January 1957. The minimum winter temperature of the surface waters, amounting to –0.2°C. was found in March 1956.

Station G_2 in the Gdansk Deep was constantly under observation. No greater changes were noted in this region. The salinity of the water layers near the bottom remained in the 11—12‰ range. The temperature of these layers was subjected to small changes and oscillated between 4.15° and 5.6°C.

The oxygen saturation of the bottom layers did not exceed 3.8 ml. O_2/l. and a minimum of 0.59 ml. O_2/l. occurred in December 1957.

J. Filarski

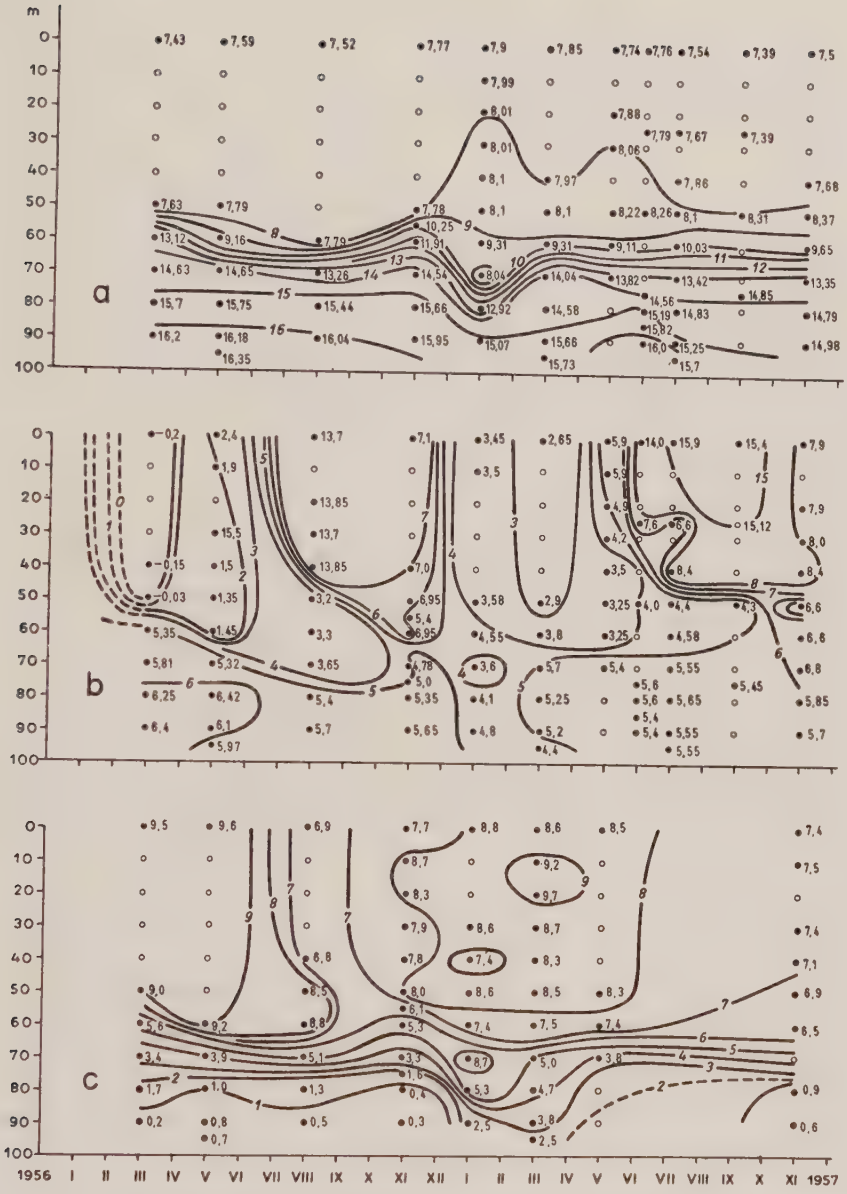

Figure 1. Bornholm Deep. Station B_1, 55°19′N., 15°44′E.
(a) = salinity; (b) = temperature; (c) = oxygen content.

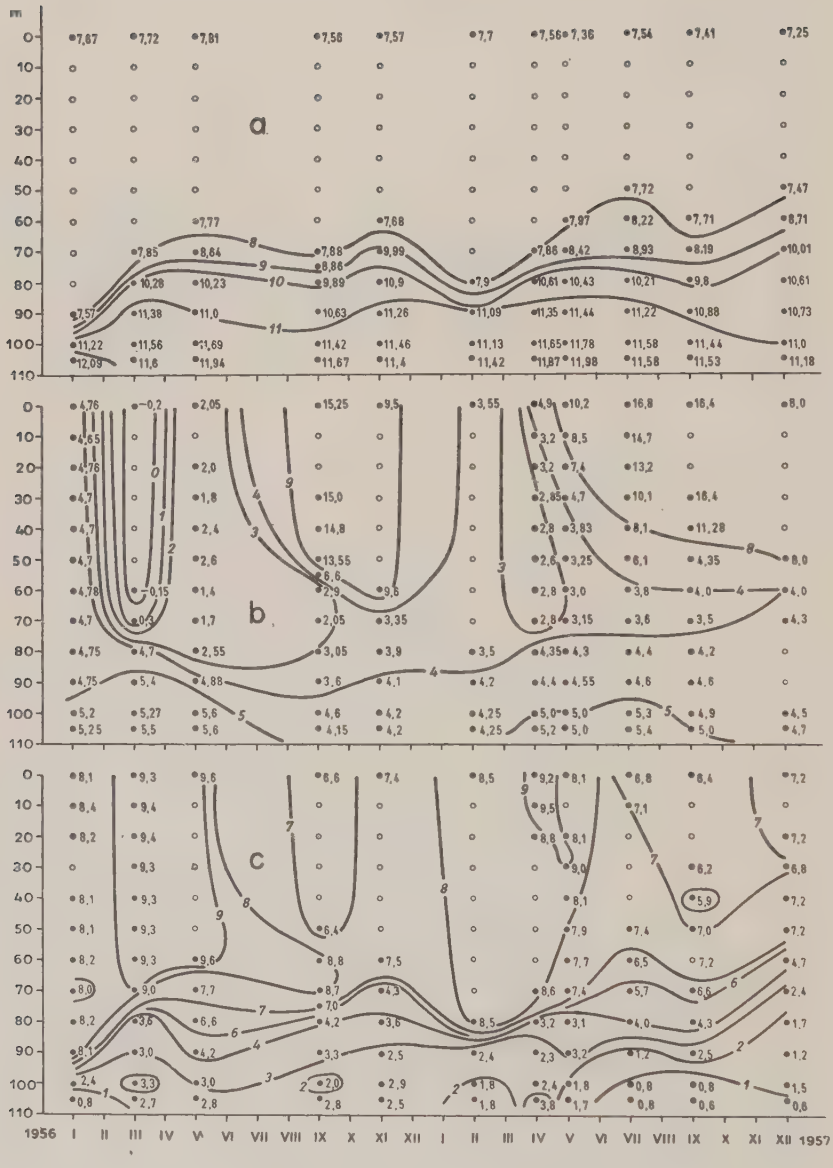

Figure 2. Gdansk Deep. Station G_2, 54°50′N., 19°16′E.
(a) = salinity; (b) = temperature; (c) = oxygen content.

Plankton

Plankton at Bornholm

At Christiansø to the north-east of Bornholm 10 vertical samples with the Hensen net were taken from a motor-boat during May—December and 8 samples round Bornholm in August from the S/S "Biologen". The means of the fat content were as follows: –

	Month	Number of samples	Mean of fat %	Range %
1957	May	2	2.9	2.8— 3.0
	June—July	3	31.3	21.3—37.5
	August	9	23.0	13.4—43.2
	October—November	2	34.8	32.0—37.5
	December	2	25.5	22.0—29.0
1956	August	12	11.3	8.6—20.1

In May the plankton was unusually abundant, especially in one of the samples, but it was almost exclusively phytoplankton and the fat content was therefore very low. The fat content in the summer and autumn months was very much higher than in the cold summer of 1956, the mean value in August being 11.3% for 12 samples, and the range 8.6—20.1%. The average for August for a longer series of years is about 22%.

The fat content of the herring was good, whereas in 1956 the quality of the herring was extremely poor. As has previously been pointed out a positive correlation exists between the fat content of the plankton and that of herring, although it may fail in some years.

Aage J. C. Jensen

Zooplankton and Biomass in the Central Baltic and the Gulf of Riga in 1957

(Table 7)

In the period from May to October plankton surveys were undertaken in the Baltic and, from January to October, also in the Gulf of Riga. The amount and biomass of zooplankton in 1957 were generally above the mean values for 1949—57 (see Table 7).

In May-June in the Baltic and in April in the Gulf of Riga the abundance of plankton reached its maximum for the whole period of observations since 1948. Especially plentiful were nauplii and I-III copepodid stages of the major species of Copepodae: *Pseudocalanus elongatus* and *Temora longicornis* in the Baltic, and *Acartia bifilosa* and *Eurytemora hirundoides* in the Gulf of Riga. The unusually favourable development of zooplankton from April to June is apparently explained by the very intensive discharge of river water during the first three months of the year. In January the outflow from the river Zapadnaya Dvina reached

Table 7. Numbers of Crustacea and biomass of zooplankton in the central Baltic and Gulf of Riga in 1957

Central Baltic

	Numbers per 1 m.³						Biomass, mg./m.³					
Depth of haul	0–25 m.		25–50 m.		50–100 m.		0–25 m.		25–50 m.		50–100 m.	
Year	1957	1949–57	1957	1949–57	1957	1949–57	1957	1949–57	1957	1949–57	1957	1949–57
May	49,280	18,670	5,820	3,950	6,150	3,070	246	100	49	33	63	54
June	41,650	19,730	15,350	10,370	3,160	3,450	213	225	109	172	77	60
August	8,110	11,400	6,180	4,830	9,030	4,170	180	207	201	161	280	160
September	18,630	11,850	14,250	7,900	2,980	3,540	250	197	261	194	(27)	140
October	5,370	5,970	3,650	4,110	5,530	3,140	70	116	76	113	214	130

Gulf of Riga

	Numbers per 1 m.³				Biomass, mg./m.³			
Depth of haul	0–20 m.		20–40 m.		0–20 m.		20–40 m.	
Year	1957	1949–57	1957	1949–57	1957	1949–57	1957	1949–57
January	1,840	3,720	300	(300)	27	32	20	(20)
February	1,640	3,010	700	(700)	22	46	21	(21)
March	3,040	—	—	—	(32)	(32)	—	—
April	25,940	10,567	3,250	1,560	99	56	20	(13)
May	—	7,100	—	2,620	—	134	—	97
June	14,530	10,700	—	—	206	180	—	137
July	17,100	21,380	9,950	7,090	207	310	286	211
August	27,100	19,330	11,580	6,570	277	344	351	234
September	13,170	14,840	12,670	13,400	338	231	(704)	402
October	(960)	3,125	(20,530)	6,380	139	170	201	126

164% of the long-period average, and in February 292%. Of great importance to the impetuous outburst of phytoplankton at the beginning of spring was also the favourable light conditions (115% of the long-period average of sunlight hours for March in the Riga area).

Another reason for the very great abundance of planktonic Crustacea from April to June may be that the late spring and the slow heating of the water prevented it from being eaten by pelagic fish.

From August to October the amount of plankton was slightly higher than the average. The decrease took place mainly on account of the slow development of *Cladocera* (July—September) and the intensive feeding of pelagic fish, chiefly a very rich population of sprat.

As regards the Arctic species constituting the main food supply of the Baltic herring in the Gulf of Riga, such as *Limnocalanus grimaldii*, *Mysis oculata* var. *relicta*, and *Mysis mixta*, these species were less abundant in 1957 than in 1948, 1954, and 1956.

I. Nikolaev

THE FISH

Eggs and Larvae

German Investigations in the Belts and Western Baltic

(Tables 8–9)

In the 1957 spawning season, the average numbers of eggs per m². near the "Fehmarnbelt" lightvessel were as given in Table 8.

The spawning of the cod began in the second half of December, but was interrupted by low water temperatures in January. The number of cod eggs was the lowest ever observed since the beginning of this survey in 1934, only amounting to one-fifth of the average for 1934—1943. The frequency of plaice eggs has increased somewhat compared with previous years, though they are still very scarce. The spawning of dab and sprat was considerably retarded, at least in the Fehmarnbelt, probably by unfavourable water conditions. The quantity of eggs of these species was extremely small, and flounder eggs were also present only in April in sufficient numbers. It is doubtful whether the occurrence of pelagic fish eggs in the Fehmarnbelt is representative of the spawning intensity in the whole area. Mackerel eggs were more frequent than in the previous year; the highest number observed was 20 per m.² on 1. July.

A week earlier a cruise was started to investigate the spawning places of mackerel in the Belt Sea in the waters around Fyn. The results of the quantitative hauls with the Hensen net are summarized in Table 9, giving the average number per m.² of mackerel, sprat, and dab eggs.

Most mackerel eggs were taken in the southern part of the Great Belt – between the isles of Langeland and Lolland – and in the northern Kiel Bay, with a maximum of 36 per m². near Kelds Nor. In the northern part of Great Belt, between Fyn and Seeland, the frequency was much lower and in Little Belt no eggs were taken in the vertical hauls. With regard to eggs of sprat and dab the distribution is quite different, the highest average numbers being found in the northern Great Belt

Table 8

		Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Cod	1957	0.5	—	14	15	4	1	0.5	—	—
	1934–43	4	15	81	49	24	3	1	—	—
Plaice	1957	—	1	1.5	1	0.5	—	—	—	—
	1934–43	0.5	0.5	2	1	1	—	—	—	—
Flounder and Dab	1957	—	—	—	32	3	3	1	14	1
	1934–43	—	—	8	23	35	35	18	3	—
Sprat	1957	—	—	—	—	—	—	—	2	0.5
	1934–43	—	—	—	—	—	22	60	60	5
Mackerel	1957	—	—	—	—	—	—	1.5	7	—
	1934–43	—	—	—	—	—	—	1.5	0.2	—

Table 9. Average numbers of mackerel, sprat, and dab eggs per m.² in the Belt Sea, 24.–26. June 1957

	Northern Great Belt N. of 55°10′N. E. of 10°15′E.	Southern Great Belt S. of 55°10′N.	Northern Kiel Bay between 4°35′N. and 55°10′N.	Little Belt N. of 55°10′N. W. of 10°15′E.
Number of stations	4	4	3	5
Mackerel	4.5	21.3	14.3	0
Sprat	12.8	4.5	0.3	8.2
Dab	30.8	7.8	11.0	13.6

and in Little Belt. By these figures the failure of the spawning of the sprat in Kiel Bay in 1957 is proved. A few anchovy eggs were observed north of Fyn only, at the same place where a great number was found last year at the beginning of July.

R. KÄNDLER

Flatfish

The 0- and I-Groups in Danish Coastal Waters

(Table 10)

As usual the occurrence of young flatfish was investigated by hauls with the Johansen young-plaice trawl in the inshore waters of the Belts, Sound, and western Baltic; at Bornholm the hand push-net was used. Except at Bornholm, an iron chain placed in front of the footrope was used, and the figures for the amount of 0-group flatfish are therefore slightly too high in relation to those of former years, but a sufficient number of comparative hauls for fixing the exact relation has not been carried out.

North of Fyn(round Samsø) and in Great Belt the number taken of 0-group **plaice** was about double the normal for the previous years but, due to the change of gear, the strength of the year-class must be assumed to have been about normal. In the Little Belt the number of 0-group plaice was very much above normal, and the density was higher than that in Great Belt and north of Fyn, a fact which is very unusual. The numbers in the western Baltic are, on the average, only half those in the Belts (see Table 10). The abnormal distribution may be explained by the strong inflow of salt water in February. No investigations were carried out in the Sound north of Copenhagen, but in the southern part the density was surprisingly high. The 0-group plaice was also very plentiful at Bornholm, about 8 times the normal. The good year-class is in accordance with the warm winter, but as is mentioned in Ann. Biol., **13**, p. 118, the great quantity of spawning fish present may have contributed to a comparatively high number of 0-group plaice. The number of I-group plaice on the coasts was small.

The 0-group **flounder** were taken in small quantities only in the Belts and western Baltic, but at Bornholm the number was somewhat above the normal (see Table 10). The occurrence of I-group flounder was above normal in the southern part of the Little Belt, corresponding to the more than normal quantity of the 0-group found there in 1956.

Table 10. Numbers of 0- and I-group plaice and of 0-group flounder and turbot caught per hour with the Johansen young-plaice trawl and the hand push-net (h.p.) in 1957

( ) = means for a series of years, see the text

	Number of stations	Plaice 0-group	Plaice I-group	Flounder 0-group	Turbot 0-group
Belts					
July–August	75	104 (28)	4	4 (0.4)	0.1 (2)
Western Baltic					
August	9	87 (14)	2	0 (2)	0.0 (1)
Sound, July (South of Copenhagen)	5	72	1	58	0.0 (4)
Eastern Baltic					
August (Præstø Bay)	2	46	5	230	0
Bornholm					
August (h.p.)	11	131 (17)	0	907 (231)	62 (25)

Table 11. Danish catch of plaice per hour in hauls with the standard trawl in 1957
(Preliminary age determinations)

	Depth zone m.	Number of stations	Age-groups 0	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
Belts														
Sept.–Dec.	5–14	19	1	2	37	4	1	0.2	—	—	—	—	—	45
	15–24	17	—	0.5	25	4	0.4	—	—	—	—	—	—	30
	>25	10	—	1	7	4	1	—	—	—	—	—	—	13
Western Baltic														
Sept.–Dec.	5–14	1	—	—	—	2	—	—	—	—	—	—	—	2
	15–24	14	—	0.1	0.9	3	1	0.3	—	—	—	—	—	5
	>25	5	—	—	7	3	—	—	—	—	—	—	—	10
Sound														
Aug.–Nov.	15–24	7	—	—	8	8	9	5	2	0.3	2	0.6	2	37
	>25	5	—	—	30	27	6	2	2	—	—	—	—	67
Møen region														
Aug.–Nov.	15–31	4	—	—	4	1	0.5	—	—	—	—	—	—	6
Bornholm region														
August	30–70	6	—	1	2	0.3	1	—	—	—	—	—	—	4
	71–91	6	—	—	—	—	—	—	—	—	—	—	—	0

			Centimetre groups 6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	
Belts														
Aug.–Dec.	5–14	20	0.6	3	9	24	8	0.8	—	—	—	—	—	45
	15–24	17	—	—	0.5	8	14	3	0.2	—	—	—	—	26
	>25	22	—	—	0.9	3	5	1	0.3	—	—	—	—	10
Western Baltic														
Oct.–Dec.	5–14	1	—	—	—	—	2	—	—	—	—	—	—	2
	15–24	15	—	—	—	0.1	1	2	1	0.1	—	—	—	4
	>25	5	—	—	—	0.8	1	6	2	0.4	—	—	—	10
Sound														
Aug.–Nov.	15–24	7	—	—	—	0.4	9	8	10	4	3	1	1	36
	>25	5	—	—	—	4	38	18	5	0.4	—	—	0.8	66
Møen region														
Aug.–Nov.	15–31	4	—	—	—	1	4	—	—	—	—	—	—	5
Bornholm region														
August	30–70	6	—	—	—	0.7	1	2	0.3	—	—	—	—	4
	71–91	6	—	—	—	—	—	—	—	—	—	—	—	0

The number of **turbot** taken at Bornholm was below normal, and very few were found on the other coasts.

Of **brill** small quantities were caught in all regions.

Of the 0-group **sole** small quantities only were taken in the northern Belt Sea.

AAGE J. C. JENSEN

The Stock of Plaice in the Open Sea

(Table 11)

The number of plaice caught per hour from the "Biologen" is shown in Table 11. In the Belts the number of plaice over the size limit was rather higher and the number under the size limit rather lower than in the preceding year (see Ann. Biol., **13**, p. 118, Table 14). In October-December the number of plaice caught in the Belts was considerably lower than in June—August, no doubt in consequence of the season; in the autumn a smaller number of plaice is caught than in summer because the fish keep closer to the bottom when the temperature is lower.

Most of the plaice in the Belt Sea belonged to group II (the 1955 year-class), but in some places, especially the northernmost regions and in the Little Belt and western Baltic, group III was just as numerous.

The prospects for the fishery in 1958 are similar to those of 1957, but the stock of commercial plaice will decrease somewhat in the course of the year on account of the good 1954 and 1955 year-classes being outfished.

In the Sound, at depths of more than 14 m., the stock of plaice was very dense and as usual it

consisted almost exclusively of plaice over the size limit; in November more than half of the fish were 31 cm. long. Also in this case most of the fish belonged to the II and III groups, 30% were, however, of the IV-group and older, and one-tenth were even 6—12 years old. Fishing with trawl and seine is prohibited in the Sound and the good quality of the stock must be ascribed to this fact. The effect of the limited fishery extends to the neighbouring areas and from Table 11 it is seen that the plaice is fairly large at Møen also. Round Bornholm, in the places where it was possible to operate experimental fishing the stock of plaice was as usual very sparse. As in 1956, the fishermen, however, took good catches near the coast. The density of the commercial stock is improved by the entry of the strong 1954 year-class.

Aage J. C. Jensen

Danish Commercial Catches of Plaice

(Table 12)

In Sejerø Bay in the northern Belt Sea (N.W. of Seeland) the mean length of plaice caught in September 1957 was somewhat lower than in September 1956, this being due to the presence of the rich 1955 year-class which caused larger quantities of fish just over the size limit to be caught in the summer and autumn of 1957 than were taken in 1956 (see Table 12).

At Bornholm three commercial landings were measured in May 1957. In Table 12 the length of the fish is compared with the length of a sample from April 1954, the only one available from previous years from this season, and with the length of a sample from October 1956. In both of the spring catches the females constituted about two-thirds. This is partly due to the fact that in the Baltic the growth-rate of the males is considerably less than that of the females and that fewer of the males are therefore over the Danish size limit of 26.0 cm. But a contributory reason may be that the males will stay for a longer time on the spawning grounds than the females, as pointed out by A. C. Johansen.

The fishing for plaice at Bornholm is not as intensive as in the Kattegat or the Belts on account of the large stony areas at depths less than 40—60 m. where trawling can be carried out only in a few places. The plaice are mainly found at sandy grounds among the stones except in spring when the mature fish migrate to deeper water in order to spawn. In the sample from about the same place in October 1956 the males were predominant and the mean length of the females was about 6 cm. less. The larger females at this time were present at the lower depths.

Aage J. C. Jensen

Transplantation of Plaice to the Belt Sea

The transplantations of plaice from the Nissum Broad to the Belt Sea were carried out from 28. March to 8. May.

60,000 kg. corresponding to 872,000 specimens were liberated in various parts of the area.

A total of 2,400 plaice was tagged, 1,300 with the Petersen disks and 1,100 with the roll-tags. Furthermore 700 plaice, caught in the Belt Sea (local Belt Sea plaice), were tagged with the roll-tag.

The recaptures of tagged transplanted plaice were small. By the end of the year 4.7% of the plaice tagged with Petersen disks were recaptured (1956, 10.5%; 1955, 9.0%; 1954, 9.0%). Only 1.9% of the plaice tagged with the roll-tag were recaptured (1956, 8.8%; 1955, 7.1%; 1954, 6.7%). The recaptures of tagged local plaice were at the same time 28.3%.

As in 1955 and 1956 the relatively best result was obtained in the Smålandshavet, where 8% of the disks and 4% of the roll-tags were recovered.

Table 12. Length distribution (‰) of plaice in Danish commercial catches

Year	Month	Number of samples	Depth, m.	Sex	Length groups, cm. 26–30	31–35	36–40	41–45	46–50	Total	Mean length, cm.
Sejerø Bay (N.W. Seeland)											
1956.....	IX–XII	3	19–26	♂ + ♀	283	413	230	68	—	999	33.8
1957	IX–XI	2	21	♂ + ♀	782	212	6	—	—	998	29.4
West of Bornholm											
1954	IV	1	40–50	♂ + ♀	273	455	213	60	—	1001	33.9
1956	X	1	50	♂	507	87	—	14	—	608	31.8
				♀	102	102	145	29	14	392	
1957	V	1	40–50	♂	208	111	42	—	—	361	35.3
				♀	42	208	236	125	28	639	

Table 13. Catch of dab per hour in experimental fishing

	1957 Spring	1957 Autumn	1957 Spring and autumn	Number of stations	1956 Spring and autumn	1955 Spring and autumn
N. Belts	230	264	253	28	460	787
S. Belts	17	50	41	57	81	586
W. Baltic	9	55	50	21	27	82
Sound	138	121	117	15	137	71
Møen	6	6	6	7	36	12
Bornholm	—	0.5	0.5	12	0.9	1.7

Table 14. Size distribution (%) of dab in 1957 in Danish catches with the standard trawl

	N. Belts		S. Belts		Sound		W. Baltic	Møen		Bornholm
cm.	Spring	Autumn	Spring	Autumn	Spring	Autumn	Autumn	Spring	Autumn	Autumn
<16	10.7	31.1	7.0	27.9	1.6	3.0	18.9	—	—	—
16–19	45.9	47.8	32.0	27.2	22.4	14.1	19.0	—	—	—
20–23	34.8	17.7	42.2	31.9	38.3	37.1	31.2	—	—	—
24–27	7.1	3.1	17.2	11.6	30.0	34.6	24.1	—	—	—
28–	1.5	0.3	1.6	1.4	7.7	11.2	6.8	—	—	—
Number of fish	253	2076	128	1059	183	661	353	3	17	3

The estimated value of the yield from the liberations in 1957 was only about one-tenth of the expenditure.

These unsatisfactory results, obtained by the transplantation this year and the foregoing years, are above all due to the fact that the size of the plaice transplanted has been too small.

A five-year period, in which tagging experiments in connexion with the transplantations have been carried out, is now finished, and the results will be published as soon as possible.

OLE BAGGE

The Stock of Dab in the Open Sea

(Tables 13–14)

The average numbers of dab caught per hour's fishing with the standard trawl from "Biologen" are given in Table 13.

In all areas except the western Baltic the stock of dab was inferior to that of 1956. The deficit is especially distinct in the northern part of the Belts.

In comparison with 1955 the stock of dab in all areas except the Sound has decreased very much.

The size composition of the stock in spring and in autumn in the northern Belts, the southern Belts, the Sound, and the western Baltic is shown in Table 14.

It is conspicuous that the smallest dabs are found in the Belts in spring as well as in autumn (80—90% are smaller than 24 cm.) and the greatest in the Sound and the western Baltic.

OLE BAGGE

Swedish Investigations of Flatfish

(Table 15)

In connexion with trawling experiments with the "Skagerak" in the southern Baltic in the period 20. May—19. June 1957 measurements were obtained from the catches of flatfish.

The covered cod-end technique was applied, using a cotton sprat-netting as cover. Consequently, is was possible to retain even very small flatfish.

The investigations, which covered ca. 79 trawling hours, were carried out in the following main areas (see Ann. Biol., **12**, p. 122): A) ca. 25 miles S.S.E. of Trelleborg, depth ca. 47 m., 14 trawling hours; B1) ca. 20 miles W.S.W. of Rønne, depth ca. 49 m., 9 trawling hours; C) ca. 12 miles E.S.E. of Simrishamn, depth ca. 70 m., 4 trawling hours; C1) ca. 23 miles E.S.E. of Simrishamn, depth 76—90 m., 10.2 trawling hours; D) ca. 11 miles S.E. of Dueodde, Bornholm, depth ca. 70 m., 12.25 trawling hours; E) ca. 16 miles S.E. of Utklippan, depth 61—70 m., 12 trawling hours; F) S.S.E. of Gothland (ca.

Table 15. Plaice, flounder, and dab

Area, date, and species	Total number	Number per hour	Length distribution (percentage in each 5 cm. group) 11–15	16–20	21–25	26–30	31–35	36–40
A. 13.–17. VI.								
Plaice	188	13.4	2.1	2.1	25.5	54.2	12.2	3.7
Flounder	75	5.4	—	13.3	46.7	28.0	8.0	4.0
Dab	109	7.8	12.8	19.3	57.8	9.2	0.9	—
B[1]. 17.–19. VI.								
Plaice	18	2.0	—	5.5	11.1	22.2	33.3	27.8
Flounder	3	0.3	—	—	(33.3)	(66.6)	—	—
Dab	17	1.9	5.9	11.8	52.9	17.6	11.8	—
C. 20. V.								
Plaice	31	7.7	—	12.9	35.5	38.7	9.7	3.2
Flounder	82	20.5	—	2.4	47.5	39.0	9.8	1.2
Dab	7	1.75	—	(28.6)	(57.2)	(14.3)	—	—
C[1]. 21.–22. V.								
Plaice	5	0.5	—	—	—	(60.0)	(20.0)	(20.0)
Flounder	59	5.8	—	—	42.4	50.8	6.8	—
Dab	—	—	—	—	—	—	—	—
D. 23.–28. V.								
Plaice	46	3.8	—	26.1	43.5	23.9	4.3	2.2
Flounder	162	13.2	—	16.1	56.2	25.3	1.2	1.2
Dab	1	0.1	—	—	—	—	(100.0)	—
E. 29.–31. V.								
Plaice	—	—	—	—	—	—	—	—
Flounder	25	2.1	—	12.0	64.0	16.0	8.0	—
Dab	—	—	—	—	—	—	—	—
F. 4.–5. VI.								
Plaice	—	—	—	—	—	—	—	—
Flounder	70	7.0	—	8.6	48.6	42.8	—	—
Dab	—	—	—	—	—	—	—	—

55°31′ N., 19°06′E.), depth ca. 89 m., 10 trawling hours.

Table 15 gives an idea of the density and length distribution of the flatfish stocks in the main localities. Compared with the winter and early spring conditions in 1955 (see Ann. Biol., **12**, p. 122) the scarcity of flatfish is obvious. This is no doubt mainly a seasonal effect. In summer young plaice are more abundant than in winter and spring — probably on account of the later spawning season of the young fish.

In the easternmost areas, E and F, no plaice and dab were caught at all.

G. Otterlind, G. Sellerberg

Quantitative Fishing of Dermersal Fish with the Standard Trawl

(Tables 16–17)

Trawling experiments were continued with the R/V "Südfall" on various fishing grounds in the Kiel Bay during the period 9. April—14. June 1957. The results of 25 trawling hours regarding average length and age distribution for each species, are shown in Tables 16 and 17.

Table 16. Number of cod, whiting, plaice, flounder, and dab caught per hour's fishing with the standard trawl in the western Baltic, April—June 1957

Length, cm.	Number per 1 hour's trawling Cod	Whiting	Plaice	Flounder	Dab
6—10	—	0.3	—	—	—
11—15	2.2	5.9	—	—	1.6
16—20	7.2	2.2	0.05	—	12.6
21—25	3.0	0.4	0.9	0.4	16.6
26—30	7.7	0.3	1.8	0.5	6.2
31—35	15.4	—	0.8	0.1	1.3
36—40	10.9	—	0.2	0.1	0.1
41—45	9.1	—	0.05	—	—
46—50	7.6	—	—	—	—
51—55	3.3	—	—	—	—
56—60	1.1	—	—	—	—
61—65	0.4	—	—	—	—
66—70	0.2	—	—	—	—
71—75	0.2	—	—	—	—
>76	0.1	—	—	—	—
Total	68.4	9.1	3.8	1.2	38.5
number examined ..	1574	226	94	29	964

Cod. The main concentration was observed in the Hohwacht Bay and off Kieler Förde, where good catches had been obtained in May and June. Compared with the year before, the age-groups II and III were much more abundant. In October 1956, already, these groups were fairly numerous.

Table 17. Number of various age-groups of cod, whiting, plaice, flounder, and dab caught per hour's fishing with the standard trawl in the western Baltic, April—June 1957

Age-group	Number per 1 hour's fishing				
	Cod	Whiting	Plaice	Flounder	Dab
I	12.0	6.5	—	—	—
II	29.5	2.0	2.2	0.3	4.5
III	22.0	0.6	1.1	0.6	28.9
IV	3.9	—	0.5	0.2	4 0
V	0.7	—	0.0	0.1	0.9
VI+	0.3	—	—	—	0.1
Total	68.4	9.1	3.8	1.2	38.5

Whiting. This species was considerably less frequent than in 1956, only 9 were caught per 1 hour's fishing compared with 30 and 90 in May and October 1956. Fish more than 20 cm. long were more frequent.

Plaice and **Flounder.** The catches were very small and consisted mainly of age-groups II and III, 20—35 cm. in length. The largest catch of plaice (16 per hour) was obtained near the lightship "Kiel".

Dab. The number of this most frequent flatfish has decreased to less than half, the 1955 year-class being less numerous than the preceding one.

R. Kändler

Eel

Forecast of the Yield of the Silver-Eel Fishery

The yield of the silver-eel fishery in the Belt Sea and the Baltic was predicted from the summer temperature of the surface water on the coasts to be about 15% above normal. Owing to a change in the methods for collecting the fishery statistics and the abolishment of the size limit for silver-eel it is difficult to compare the quantities caught in each of the preceding years, but according to the reports of the fishery control to the Ministry of Fisheries the yield was below normal on most of the coasts, only in some localities about normal or a little above. It is pointed out in one of the reports that the strongest migration in October had taken place before the dark period, when only some few pound nets were standing in the sea. The great frequency of westerly winds in October might have been expected to give good fishing on many of the coasts, but the currents were often so strong that the pound nets worked badly.

The extent of the **tumour disease** was about the same as in the preceding years and must have contributed to the poor fishery.

Aage J. C. Jensen

Observations on Migrations

In 1957 diurnal migrations of eel in the lower part of the Gauya river (Latvian SSR) were investigated.

Observations by M. Kundzinsh (Latvian State University) confirmed nightly migrations of eels into the Gulf; *Mesidothea entemon* were found in their stomachs in the morning, while at night stomachs were empty.

P. Borisov

Gadoid Fish

INTRODUCTION

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YOUNG STAGES

Greenland

Cod Fry and Small Cod in Coastal Waters and on the Offshore Banks of West Greenland, 1957

(Figures 1–2; Table 1)

1. Occurrence of cod eggs and fry

Table 1 shows the number of cod eggs and larvae taken in the region of Godthåb Fjord. Figure 1 shows the position of the stations. The fishery was operated with the 1 m. stramin net and, from 1. May, at all stations also with the 1 m. nylon net of the same mesh size as the stramin net. The catches taken with the nylon net are given in parentheses in the table. The nets were hauled for half an hour with 100—50 m. wire out. It will be seen that in most cases the nylon net yielded much greater catches than the stramin net. The table includes only hauls made in the period February to July. On 9., 22., and 24. January fishery with the stramin net was operated at Stations 4, 6, and 7. In none of these hauls cod eggs were taken.

On the largest cod spawning ground, Station 4 in Godthåb Fjord, 20 cod eggs were taken on 21. February in one haul with stramin bag and 100—50 m. wire out. At this station and on the same date 88 cod eggs were taken in one haul with 400 m. wire out (this haul is not indicated in Table 1). In March the catches contained much larger numbers of eggs at Station 4 than at the nearby stations; but in April fewer eggs were taken at Station 4 than in March.

In general, there seems to have been a sparser occurrence of cod eggs in Godthåb Fjord in 1957 than in the previous year.

The first cod larvae were caught at the beginning of May at Station 7 at the entrance to the fjord, and at the same station the larvae were also most plentiful in the latter half of June.

Figure 2 shows catches taken with the 2 m. stramin net at the "Dana" stations in Davis Strait in July. The number of cod larvae in the hauls was generally much greater than in previous years. The distribution of larvae in the southern part of the strait was far more westerly than usual. Thus, no cod larvae at all were taken on the Fylla, Fiskenes, and Dana Banks, while large numbers were caught at the stations far westward outside the banks.On Lille Hellefiske Bank, however, some cod larvae were caught, but west of this bank larger numbers were caught than at the stations over the

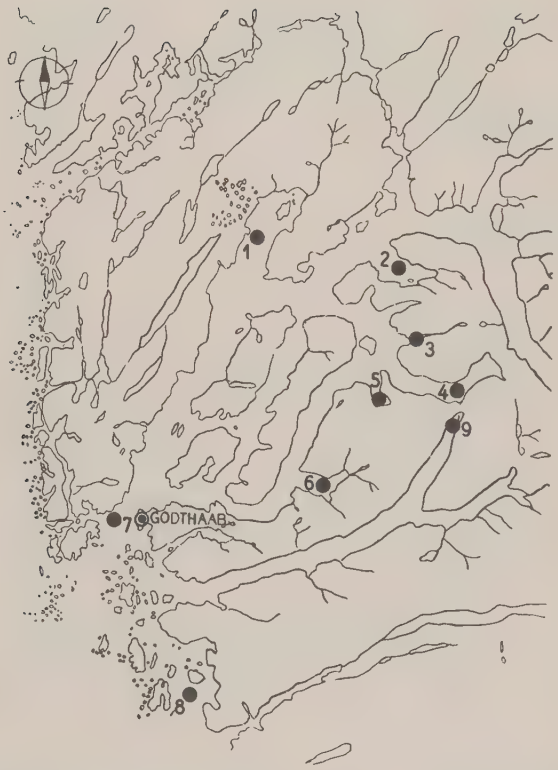

Figure 1. The positions of the stations at which cod eggs were taken in 30-minute hauls with the 1 m. stramin net and the 1 m. nylon net by "Adolf Jensen" and "Tornaq" with 100—50 m. wire out.

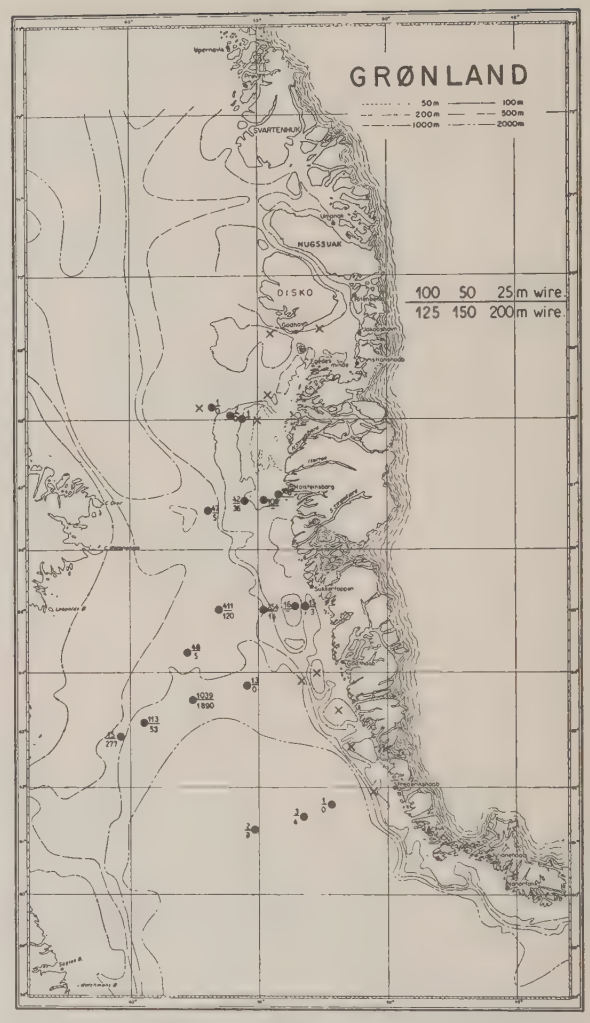

Figure 2. Catches of cod larvae in 30-minute hauls with the 2 m. stramin net taken by "Dana".

bank. On the southern part of Store Hellefiske Bank, however, the largest numbers of cod larvae were obtained at the stations over the bank. At the northern stations of this bank only few cod larvae were found in the hauls.

It is difficult, from the quantitative occurrence and distribution of the cod fry in 1957, to judge whether the stock of cod originating from that year will be rich or poor.

The westerly occurrence of larvae might indicate that the current had carried large numbers off to depths where they may be destroyed on attaining the bottom-seeking stage, provided they are not carried across to Labrador and thus withdrawn from the Greenland stock. However, the fairly abundant occurrence of cod larvae along the coast and over Store Hellefiske Bank may suggest that a sufficiently large quantity of larvae may develop and form a good 1957 year-class, which in 1962 for the first time may be of importance to the fisheries.

2. Occurrence of small cod of age-groups I, II, and III

Small cod were very sparsely encountered in the coastal and fjord regions, and in one case only a fairly large number was taken in seine nets. This catch was taken in the district of Sukkertoppen, in 64°48′N., 52°12′W. A number of 1,139 cod were caught of length ranging from 7 to 15 cm. with a peak at 11 cm. These small cod belonged to age-group I.

PAUL M. HANSEN.

Table 1. Number of cod eggs and larvae taken in the Godthåb Fjord area

Stations		February		March		April		May		June		July	
		1.–15.	15.–28.	1.–15.	15.–31.	1.–15.	15.–30.	1.–15.	15.–31.	1.–15.	15.–30.	1.–15.	15.–31.
1	Eggs	—	—	4	—	—	—	—	—	—	—	—	—
	Fry	—	—	0	—	—	—	—	—	—	—	—	—
2	Eggs	—	—	—	—	4	—	—	—	—	—	—	—
	Fry	—	—	—	—	0	—	—	—	—	—	—	—
3	Eggs	—	—	—	134	—	—	7500 (9240)	—	—	—	—	—
	Fry	—	—	—	—	—	—	0 (0)	—	—	—	—	—
4	Eggs	—	20	—	9950	—	834	—	—	—	0 (0)	—	—
	Fry	—	0	—	0	—	0	—	—	—	0 (1)	—	—
5	Eggs	—	—	—	18	—	—	1239 (2804)	—	—	—	—	—
	Fry	—	—	—	0	—	—	0 (0)	—	—	—	—	—
6	Eggs	—	—	4	4	—	—	77 (353)	290 (519)	—	0 (0)	—	—
	Fry	—	—	0	0	—	—	0 (0)	0 (0)	—	5 (1)	—	—
7	Eggs	0	—	—	—	—	—	30 (18)	—	—	0 (0)	—	—
	Fry	0	—	—	—	—	—	6 (2)	—	—	128 (139)	—	—
8	Eggs	0	—	0	—	—	0	—	24 (7)	—	—	0 (0)	0 (0)
	Fry	0	—	0	—	—	0	—	23 (9)	—	—	20 (55)	0 (0)
9	Eggs	—	—	—	—	—	—	—	328 (1000)	—	—	—	—
	Fry	—	—	—	—	—	—	—	0 (0)	—	—	—	—

Table 2. Larval cod, haddock, whiting, and saithe, June 1956

(Total catch at 36 stations)

Length, mm.	Cod		Haddock		Whiting		Saithe	
	"Ternan"[1])	"Dana"[2])	"Ternan"	"Dana"	"Ternan"	"Dana"	"Ternan"	"Dana"
4	—	—	2	—	—	—	—	—
5–9	24	2	122	38	14	7	3	—
10–14	31	17	172	207	13	15	17	1
15–19	36	42	80	157	4	20	22	3
20–24	16	52	16	102	1	11	6	3
25–29	7	66	3	46	1	4	11	4
30–34	—	39	—	17	—	2	5	3
35–39	—	14	—	9	—	—	2	—
40–45	—	5	—	2	—	—	—	1
Total number	114	237	395	578	33	59	66	15
No. per hour	14	13	49	32	4	3	8	1
Av. length, mm.	15.4	25.1	12.4	17.5	12.2	17.0	19.3	25.2

[1]) 31. May–18. June

[2]) 20.–28. June

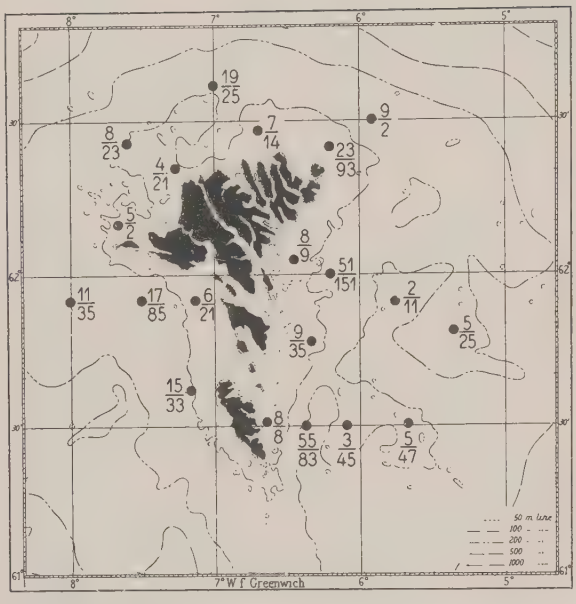

Figure 3. Numbers of larval cod (upper figure) and haddock (lower figure) per hour's haul with the 2 m. ring-trawl. June 1956.

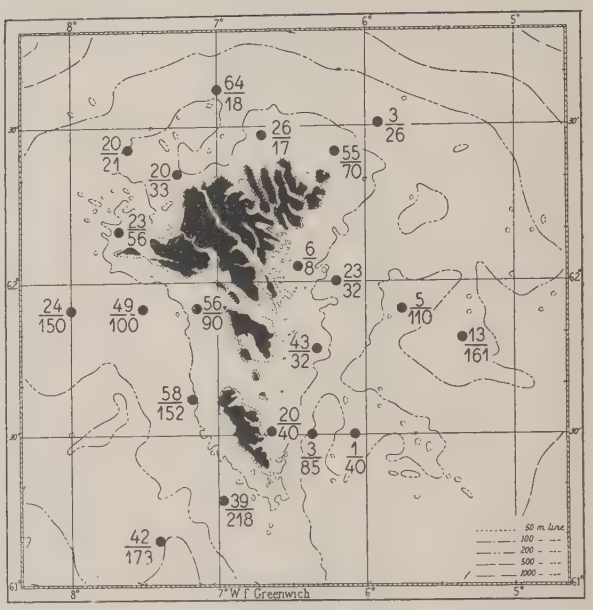

Figure 4. Numbers of larval cod (upper figure) and haddock (lower figure) per hour's haul with the 2 m. ring-trawl. June 1957.

Faroes

Pelagic 0-Group Cod, Haddock, Whiting, and Saithe

(Figures 3–4; Tables 2–3)

Hauls with the 2 m. ring-trawl were carried out by the "Ternan" and the "Dana" in June 1956 and by "Dana" in June 1957. Samples were collected at 36 stations in 1956 and at 21 stations in 1957. At most stations two oblique hauls of 10 minutes at each depth were made with the 2 m. ring-trawl (100–50–25 and 200–150–125 m. wire out). In a few cases hauls with 100–50–25 m. wire out only were made.

Compared with similar investigations in the Faroe area at the same time in previous years, the numbers of cod and haddock larvae caught per hour were very low in 1956 as well as in 1957. (In post-war years the average numbers per hour were 158 cod and 252 haddock.)

J. S. Joensen

Table 3. Larval cod, haddock, whiting, and saithe, 7.–14. June 1957
(Total catch at 21 stations)

Length, mm.	Cod	Haddock	Whiting	Saithe
5— 9	4	20	6	—
10—14	84	354	30	9
15—19	197	645	11	11
20—24	189	335	8	16
25—29	52	128	5	9
30—34	14	41	—	3
35—39	3	16	—	1
40—44	2	5	—	1
45—49	—	—	—	—
50—54	1	—	—	—
55—59	—	1	—	—
Total number	552[1])	1563[2])	60	50
No. per hour	28	80	3	2.6
Av. length, mm.	20.1	19.0	16.0	21.4

[1]) Including 6 not fit for measurement.
[2]) Including 18 not fit for measurement.

COMMERCIAL FISH

COD

Greenland Stock

Danish Investigations in the Coastal Waters and on the Offshore Banks of West Greenland in 1957

(Figures 5–6; Tables 4–6)

1. The age composition

a. Offshore banks

Age determinations were made on the basis of 1,546 otoliths. Of these, 941 were from the "Dana's" catches taken with hand-line in July—August (Nos. 1, 2, 4, 6, and 7), while 605 were from long-line catches taken from the "Adolf Jensen" (Nos. 3, 5, 8, and 9).

Figure 5 and Table 4 show the age composition of nine catches from the banks. Age analyses from Store Hellefiske Bank (Nos. 1 and 2) show a surprising dominance of the 1953 year-class, viz., about 50% of the catches. Even though, on the basis of the investigations of the previous years, the 1953 year-class was estimated to be rich it was not to be expected that already at an age of four years it would be present in such great quantities. On the banks south of Store Hellefiske Bank the 1953 class constituted only a small percentage of the catches. From a fishery point this year-class was without importance in 1957 owing to the small size of the individuals, ca. 46 cm. (0.9 kg.).

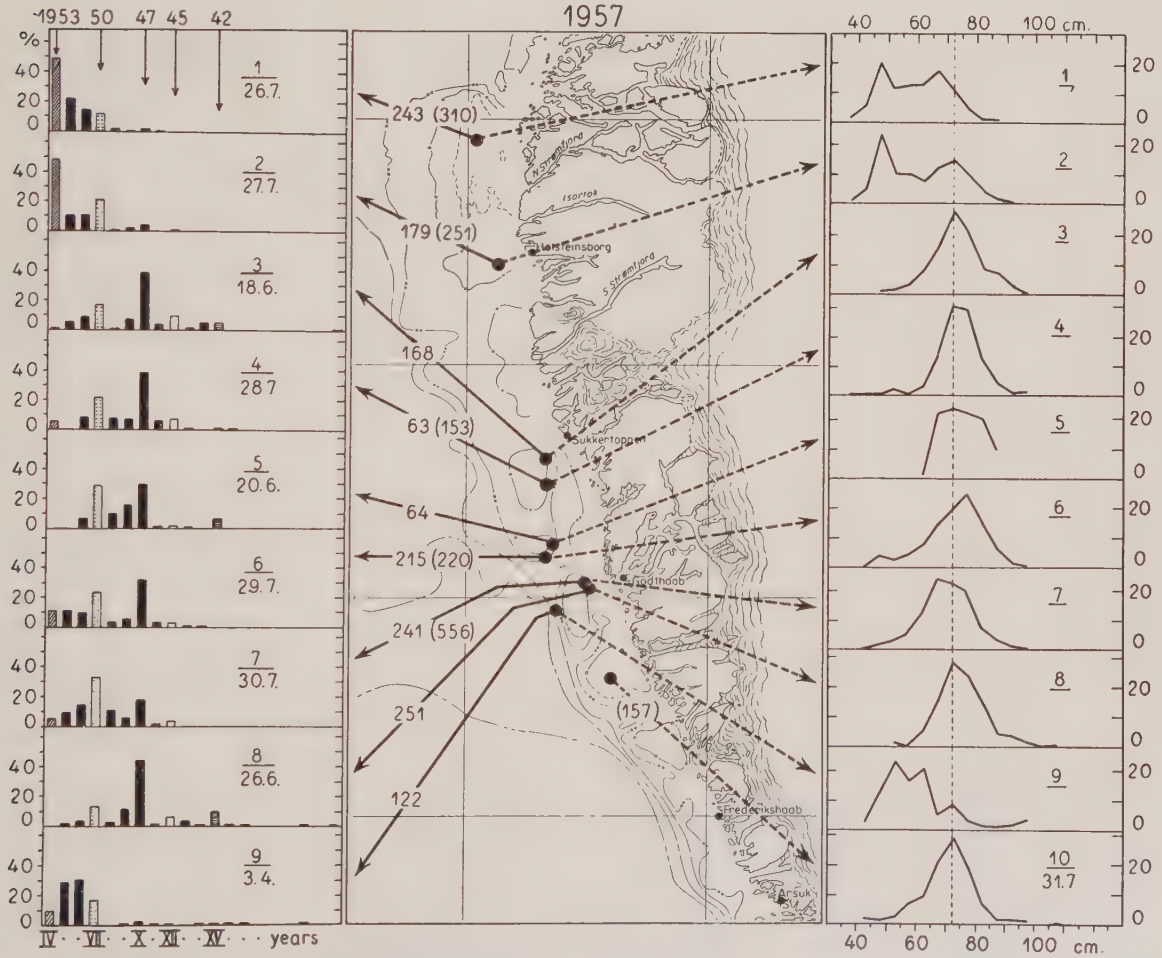

Figure 5. Percentage age distribution (left) and length measurements for 5 cm. groups (right) of cod caught on the Greenland banks in 1957. The numbers of fish examined and of cod tagged (bracketed figures) are given for each station.

Table 4. Age composition of the cod on West Greenland banks in 1957, together with the mean lengths of males and females at each age

Year-class	Age-group	1 Store Hellefiske Bank 67°49′N., 54°49′W. 26. July, 26–40 m. Length, cm. No.	♂♂	♀♀	2 Store Hellefiske Bank 66°49′N., 54°22′W. 27. July, 32–26 m. Length, cm. No.	♂♂	♀♀	3 Lille Hellefiske Bank 65°11′N., 53°15′W. 18. June, 90 m. Length, cm. No.	♂♂	♀♀
1953	IV	119	46.5	46.6	86	46.7	45.8	1	48.0	—
1952	V	51	57.0	57.1	18	59.6	52.1	9	56.5	54.2
1951	VI	35	62.7	64.9	20	63.4	63.3	14	61.7	66.1
1950	VII	30	69.1	71.5	39	70.1	71.4	28	65.6	68.2
1949	VIII	2	70.0	—	3	77.0	80.5	1	—	68.0
1948	IX	1	—	69.0	4	—	74.7	11	70.5	75.4
1947	X	4	73.0	82.0	8	80.4	78.0	64	73.4	75.9
1946	XI	1	86.0	—	—	—	—	5	77.5	78.3
1945	XII	—	—	—	1	—	83.0	16	85.5	78.3
1944	XIII	—	—	—	—	—	—	3	80.5	84.0
1943	XIV	—	—	—	—	—	—	7	80.5	82.6
1942	XV	—	—	—	—	—	—	7	76.8	86.0
1934	XXIII	—	—	-	—	—	—	2	90.5	—
Total number		243			179			168		

Year-class	Age-group	4 Lille Hellefiske Bank 64°57′N., 53°19′W. 28. July, 68–75 m. Length, cm. No.	♂♂	♀♀	5 Banana Bank 64°26′N., 53°13′W. 20. June, 60–90 m. Length, cm. No.	♂♂	♀♀	6 Banana Bank 64°21′N., 53°22′W. 29. July, 70–100 m. Length, cm. No.	♂♂	♀♀
1953	IV	3	50.0	41.0	—	—	—	23	47.9	48.4
1952	V	—	—	—	—	—	—	23	58.8	61.3
1951	VI	5	63.8	—	4	—	65.0	21	64.7	64.7
1950	VII	13	69.0	71.1	18	70.7	70.2	50	70.5	68.4
1949	VIII	4	74.0	78.3	6	68.5	81.3	6	74.0	75.3
1948	IX	4	74.7	74.0	10	73.0	74.4	11	75.8	78.0
1947	X	24	75.6	77.0	19	79.6	79.4	67	77.7	78.9
1946	XI	3	77.3	—	1	—	89.0	6	79.6	88.0
1945	XII	4	78.0	85.3	1	—	84.0	5	79.0	79.3
1944	XIII	1	78.0	—	1	—	108.0	1	—	85.0
1943	XIV	—	—	—	—	—	—	2	76.0	80.0
1942	XV	1	89.0	—	4	86.0	82.3	—	—	—
1941	XVI	1	—	90.0	—	—	—	—	—	—
Total number		63			64			215		

Year-class	Age-group	7 Fylla Bank 64°07′N., 52°33′W. 30. July, 35–70 m. Length, cm. No.	♂♂	♀♀	8 Fylla Bank 64°05′N., 52°28′W. 26. June Length, cm. No.	♂♂	♀♀	9 Fylla Bank 63°53′N., 53°28′W. 3. April, 180–200 m. Length, cm. No.	♂♂	♀♀
1953	IV	13	51.8	51.3	—	—	—	13	46.9	44.8
1952	V	22	57.4	59.0	5	53.0	57.3	36	53.0	53.2
1951	VI	34	65.3	67.2	17	64.4	61.0	38	60.1	59.7
1950	VII	80	68.2	70.5	33	66.9	70.1	22	66.2	66.6
1949	VIII	26	74.2	80.0	7	67.3	76.5	—	—	—
1948	IX	13	72.0	71.0	28	72.7	73.8	1	—	77.0
1947	X	40	78.1	79.5	110	73.9	77.3	4	74.0	79.0
1946	XI	4	73.0	83.0	4	73.0	75.0	1	—	83.0
1945	XII	9	80.0	86.3	12	76.4	81.7	2	—	92.0
1944	XIII	—	—	—	6	80.8	89.0	—	—	—
1943	XIV	—	—	—	3	77.7	—	1	—	96.0
1942	XV	—	—	—	23	81.9	84.9	1	—	94.0
1941	XVI	—	—	—	2	91.0	86.0	1	—	99.0
1940	XVII	—	—	—	4	80.7	125.0	1	—	96.0
1936	XXI	—	—	—	3	90.7	—	1	—	94.0
1934	XXIII	—	—	—	4	102.7	89.0	—	—	—
Total number		241			261			122		

Table 5. Age composition from inshore waters and fjords of West Greenland in 1957

Year-class	Samples Age-group	10 Aug. Sept. Oct.	11 Aug. Sept.	12 Aug.	13 July Aug. Sept.	14 July Aug. Sept.	15 June	16 July	17 Sept.	18 Sept.	19 March April	20 Sept.
1953 ...	IV	—	—	—	1	18	17	36	64	29	29	63
1952 ...	V	—	—	1	3	96	18	11	23	26	38	30
1951 ...	VI	—	—	—	47	231	21	23	30	16	20	10
1950 ...	VII	—	1	2	129	350	27	57	31	42	25	13
1949 ...	VIII	—	1	—	31	56	8	7	9	2	7	1
1948 ...	IX	1	1	4	38	31	3	17	6	13	—	—
1947 ...	X	14	43	15	253	181	6	40	21	45	1	3
1946 ...	XI	1	4	1	9	3	—	1	—	1	1	—
1945 ...	XII	8	13	11	34	16	—	1	12	8	—	3
1944 ...	XIII	4	5	4	7	4	—	3	—	1	—	—
1943 ...	XIV	6	11	6	4	2	—	1	1	2	—	—
1942 ...	XV	35	31	24	21	6	—	2	2	12	—	—
1941 ...	XVI	5	1	10	1	—	—	—	—	—	—	—
1940 ...	XVII	7	3	4	1	—	—	—	—	2	—	—
1939 ...	XVIII	2	1	—	—	—	—	—	—	—	—	—
1938 ...	XIX	—	—	—	—	—	—	—	—	—	—	—
1937 ...	XX	—	—	—	—	—	—	—	—	—	—	—
1936 ...	XXI	2	1	—	—	—	—	—	—	—	—	—
1935 ...	XXII	1	—	—	—	—	—	—	—	—	—	—
1934 ...	XXIII	1	2	—	—	—	—	—	—	—	—	—
Total number		87	118	82	579	994	100	199	199	199	121	123

Year-class	Samples Age-group	21a Jan.	21b Febr.	21c Febr.	21d March	21e April	21f May	21g May	22 May	23 Aug. Sept.	24 Oct.	25 May June	26 July	27 Aug.
1953 ...	IV	2	10	4	25	—	—	97	5	23	2	95	1	24
1952 ...	V	20	101	14	36	7	27	77	11	24	3	77	5	21
1951 ...	VI	4	18	2	3	4	36	11	17	18	5	44	12	31
1950 ...	VII	9	31	8	1	29	43	6	55	66	34	131	115	50
1949 ...	VIII	13	14	1	—	31	24	2	25	26	29	36	41	16
1948 ...	IX	4	6	—	—	13	10	1	2	2	10	—	5	3
1947 ...	X	7	9	5	—	51	23	5	4	14	46	25	13	13
1946 ...	XI	1	1	—	—	7	5	—	1	—	3	—	—	—
1945 ...	XII	15	14	8	—	60	22	1	2	2	11	14	7	1
1944 ...	XIII	—	—	2	—	9	2	—	—	—	—	—	—	—
1943 ...	XIV	1	—	2	—	9	3	—	—	—	1	—	—	—
1942 ...	XV	1	4	7	—	30	11	2	1	—	4	2	—	1
1941 ...	XVI	—	—	—	—	6	—	—	1	—	—	1	—	—
1940 ...	XVII	—	—	8	—	40	13	—	1	—	1	—	—	—
1939 ...	XVIII	—	—	2	—	—	—	—	—	—	—	—	1	—
1938 ...	XIX	—	—	1	—	3	—	—	—	—	—	—	—	—
1937 ...	XX	—	—	1	—	2	—	—	—	—	—	—	—	—
1936	XXI	—	—	—	—	—	—	—	—	—	—	—	—	—
1935 ...	XXII	—	—	—	—	—	—	—	—	—	—	—	—	—
1934 ...	XXIII	—	—	—	—	—	—	—	—	—	—	—	—	—
Total number		77	208	65	65	301	219	202	125	175	149	425	200	160

The rich 1947 year-class is predominant in the majority of the samples from the other banks. It would seem, however, that it has decreased somewhat since 1956. It is quite probable that like the 1945 year-class in previous years, it is migrating southward and thence further on via East Greenland to Iceland.

The 1950 year-class is represented in all the samples and was no doubt of considerable value for the yield of the bank fishery. Year-classes older than 1947 were very sparsely represented in the samples.

The length distribution (Figure 5, right) shows good agreement with the age distribution. In the two samples from Store Hellefiske Bank (Nos. 1 and 2) and in the long-line catch from April from Fylla Bank (No. 9) small cod predominate, in accordance with the fact that the samples only contain young cod. In the other samples most of the measurements range between 70 and 80 cm.,

1957
GRØNLAND
50 m
100 m
200 m
500 m
1000 m
2000 m
SVARTENHUK
NUGSSUAK
DISKO
Godhavn
Jakobshavn
Holsteinsborg
Sukkertoppen
Godthaab
Lichtenau
Frederikshaab
Julianehaab
Prins Christians Sund
Cap Farvel
Upernivik
Umanak
Egedesminde
Christianshaab
Christianshaab
Proven
Umanak
Uperniviks Isfjord
Kangamiut
Fiskenæsset
Arsuk
Qagortoq
Narssarssuak
Narssaq
Ivigtut
Arsuk Fjord
Tunugdliarfik
Kangerdlugssuak
Kangerdlugssuak
Amerdloq Fjord
Godthaab Fjord
Godthaab Fjord
Godthaab

Table 6. Age at first maturity of the 1942, 1945, and 1947 year-classes of Greenland cod in 1957

Banks off the west coast

Age	1942 year-class ♂♂ No.	%	♀♀ No.	%	Age	1945 year-class ♂♂ No.	%	♀♀ No.	%	Age	1947 year-class ♂♂ No.	%	♀♀ No.	%
*	—	—	—	—	*	—	—	—	—	*	2	1.1	2	1.2
6	5	20.8	2	15.4	6	1	5.3	1	3.8	6	9	5.2	1	0.6
7	11	45.8	6	46.2	7	7	36.8	8	30.8	7	90	51.7	53	32.1
8	8	33.3	3	23.1	8	8	42.1	13	50.0	8	57	32.8	82	49.7
9	—	—	2	15.4	9	1	5.3	4	15.4	9	16	9.2	26	15.8
10	—	—	—	—	10	1	5.3	—	—	10	—	—	1	0.6
11	—	—	—	—	11	1	5.3	—	—		—	—	—	—
Total	24		13			19		26			174		165	
Mean		7.1		7.4			7.8		7.8			7.4		7.7

Coastal area north of 63°N.

*	—	—	—	—	*	2	4.0	—	—	*	3	1.2	22	6.0
6	16	25.0	9	13.2	6	4	8.0	3	5.4	6	8	3.3	1	0.3
7	31	48.4	29	42.6	7	12	24.0	18	32.1	7	74	30.1	82	22.2
8	9	14.1	17	25.0	8	25	50.0	27	48.2	8	110	44.7	162	43.9
9	7	10.9	12	17.6	9	7	14.0	8	14.3	9	49	19.9	93	25.2
10	1	1.6	1	1.5	10	—	—	—	—	10	2	0.8	9	2.4
Total	64		68			50		56			246		369	
Mean		7.2		7.5			7.4		7.7			7.8		7.6

Coastel area south of 63°N.

*	—	—	—	—	*	—	—	1	6.7	*	—	—	3	5.8
6	—	—	—	—	6	2	10.0	1	6.7	6	5	8.6	2	3.8
7	6	100.0	1	50.0	7	7	35.0	4	26.7	7	27	46.6	18	34.6
8	—	—	1	50.0	8	8	40.0	4	26.7	8	24	41.4	24	46.2
9	—	—	—	—	9	2	10.0	2	13.3	9	2	3.4	5	9.6
10	—	—	—	—	10	—	—	3	20.0	10	—	—	—	—
11	—	—	—	—	11	1	5.0	—	—	11	—	—	—	—
Total	6		2			20		15			58		52	
Mean		7.0		7.5			7.7		7.6			7.4		7.7

Godthåb Fjord

6	7	22.6	3	13.6	6	18	24.3	14	30.4	6	5	20.0	4	15.4
7	18	58.1	8	36.4	7	36	48.6	18	39.1	7	10	40.0	6	23.1
8	5	16.1	7	31.8	8	17	23.0	12	26.1	8	7	28.0	12	46.2
9	—	—	3	13.6	9	3	4.1	2	4.3	9	3	12.0	3	11.5
10	1	3.2	1	4.5	10	—	—	—	—	10	—	—	1	3.8
Total	31		22			74		46			25		26	
Mean		7.0		7.6			7.1		7.0			7.3		7.7

East coast

*	—	—	—	—	*	—	—	—	—	*	3	12.5	5	11.6
6	—	—	4	8.2	6	—	—	2	8.3	6	—	—	—	—
7	14	60.9	23	46.9	7	4	40.0	4	16.7	7	7	29.2	4	9.3
8	8	34.8	19	38.8	8	6	60.0	9	37.5	8	11	45.8	22	51.2
9	1	4.3	2	4.1	9	—	—	6	25.0	9	3	12.5	11	25.6
10	—	—	1	2.0	10	—	—	2	8.3	10	—	—	1	2.3
11	—	—	—	—	11	—	—	1	4.1	11	—	—	—	—
Total	23		49			10		24			24		43	
Mean		7.4		7.4			7.6		8.2			7.8		8.2

* = immature fish

In the samples taken in January and February (a, b, and c) many old, mature cod are found in catches taken both with shrimp trawl (a and b) and long-line (c). In March, however, a shrimp-trawl catch (d) from the same station at which a and b were taken, consisted almost exclusively of age-groups V and IV (1952 and 1953 year-classes). The older, mature cod had then moved to the innermost parts of the fjord to spawn. Sample e was taken in April on this spawning ground and

shows a similar age distribution to that found in February a short distance farther out in the fjord. In this sample, however, cod younger than group VII are almost entirely absent.

The two samples f and g correspond fairly closely to samples e and d and show the same phenomenon, that chiefly older, mature cod occur in the inner fjord (f) while farther out the young immature fish are more plentiful.

The three samples Nos. 22, 23, and 24 were taken in the same region, in May, August—September, and October, respectively. A common feature of these samples is that the 1950 and 1949 year-classes played a rather considerable part. In No. 24, however, the 1947 year-class predominates, constituting over 30%. In the other two samples it is without importance.

In the three samples Nos. 25, 26, and 27 the 1950 year-class is predominant. In No. 26 it constitutes 57.5%, in the other two a little over 30%. The 1947 year-class constitutes only from 5 to 10% in these samples. The 1949 and 1950 year-classes together constitute no less than 88% of sample No. 26. Sample No. 25 consists of three catches taken with different gears, such as long-line, hand-line, and pound-nets. The table below gives the percentage composition of age-groups III—VI, VII—X, and XI—XVI in catches taken with each of the three kinds of gear. It appears distinctly from the table that long-lines catch a greater number of old cod than do hand-lines and pound-nets. Pound-nets fish a greater number of young cod than do the other two types of gear.

Age-groups Year-class	III–VI 1954–51	VII–X 1950–47	XI–XVI 1946–41	Number	Average length, cm.
Long-line . .	40.4	**47.1**	12.4	121	60.3
Hand-line . .	44.3	**53.9**	1.8	113	58.0
Pound-net .	**61.5**	38.5	—	192	54.5

Age at first maturity

Table 6 gives a survey of the ages at which sexual maturity sets in, determined from otoliths of cod belonging to the 1942, 1945, and 1947 year-classes. The material is collected from the following areas: the banks (off the west coast), the coastal area in the north (west coast north of 63°N.), the coastal area in the south (west coast south of 63°N.), Godthåb Fjord, and the coast of East Greenland. The greatest number of cod which had attained sexual maturity at an age of seven years belonged to the 1942 year-class, while the other year-classes seem to have attained sexual maturity at a later age, the majority generally about an age of eight years.

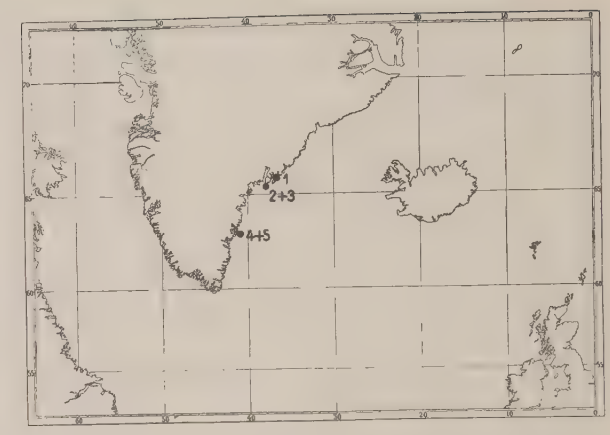

Figure 7. Localities of samples taken at East Greenland.

East Greenland

(Figure 7; Table 7)

From 9. August to 24. September investigations were made in south-east Greenland waters with the "Adolf Jensen". The work was especially concentrated within the area from 63° to 66° N. Lat.

At Angmagssalik (65°35'N., 37°35'W.) large concentrations of cod were found, and off Kungmiut in the Angmagssalik Fjord (65°51'N., 37°03'W.) good occurrences were observed. A material totalling 681 cod otoliths was determined as to age, 589 of which were collected by the "Adolf Jensen", while 92 were collected by the leader of the fisheries at Skjoldungen. The material was distributed over five samples (Nos. 1—5, Figure 7, Table 7).

No. 1 is from catches of cod taken with hand-line, a very few specimens in the sample, however, were taken with long-line. No. 2 is exclusively from catches taken with hand-line. Both samples chiefly contain the IV—VII groups (1953—1950 year-classes). No. 2 contains a much larger number of young year-classes than No. 1. In No. 1 the 1950 year-class predominates, constituting 52.5%, while this year-class and the 1952 year-class are about equally represented in No. 2, with 26.5% and 27.0%, respectively. No. 2 was taken in fairly shallow water, where large shoals of cod hunted capelins (I and II groups), which were present in very large quantities.

According to reports from Angmagssalik, a shoal of very big cod approached the coast in October. This migration of big cod late in the year had also been observed in earlier years.

Table 7. Age composition from inshore waters and the fjords of East Greenland in 1957

Year-class	Age-group	Samples 1 Aug.	2 Sept.	3 Aug.–Sept.	4 Aug.	5 Sept.
1953	IV	4	34	—	—	—
1952	V	19	54	—	2	—
1951	VI	44	45	5	2	2
1950	VII	93	53	19	10	7
1949	VIII	11	6	9	7	3
1948	IX	—	—	3	2	5
1947	X	4	2	35	6	20
1946	XI	—	—	1	2	1
1945	XII	1	—	15	5	14
1944	XIII	—	—	4	—	2
1943	XIV	—	—	4	2	2
1942	XV	—	—	28	16	30
1941	XVI	—	—	3	2	1
1940	XVII	—	—	5	3	1
1939	XVIII	—	—	1	2	—
1938	XIX	—	—	1	—	1
1937	XX	—	—	2	—	—
1936	XXI	—	—	6	5	1
1935	XXII	—	—	2	—	—
1934	XXIII	—	—	2	2	2
Total number		176	194	145	68	92

Sample No. 3 was taken with long-lines in deep water, ca. 200—300 m., partly on the bank in the open sea off Angmagssalik, partly in localities in the coastal area south of Angmagssalik. No. 4 was taken at about the same depths as sample No. 3, partly on the bank in Denmark Strait off Skoldungen Sound, partly in the sound itself. These two samples are entirely different from samples Nos. 1 and 2, consisting primarily of cod older than group X (1947). In Nos. 3 and 4 such old cod constitute 75 and 66%, respectively. The 1942 year-class makes up nearly 20% in both samples. The old 1936 and 1934 year-classes are represented in the samples, though by few specimens only.

Sample No. 5 is derived from Greenlandic catches taken with hand-line at the end of September. This sample also contains predominantly old cod, 81% being constituted by the 1947 and older year-classes. The 1942 year-class was the most abundant, with 32.6%. It was not till the end of September that cod in large quantities entered Skoldungen Sound. At the time of the investigations in August by far the majority of cod were found on the bank off the coast.

On 16. September, two specimens of cod with ripening ovaries containing rather big eggs, were caught off Angmagssalik. They would probably have spawned in October—November.

Tagging Experiments

(Tables 8–9)

In 1957 a total of 5,228 cod were tagged along West Greenland, and 567 off East Greenland.

A number of 715 tagged cod were recaptured in 1957. Table 8 shows the recaptures of tagged fish of different ages from the tagging experiments in different years. A number of 697 tagged cod were recaptured in West Greenland waters, 13 near Iceland, and three in East Greenland waters. In addition, two were caught on the Grand Banks. Of the three recaptures from East Greenland, one was taken on the Anton Dohrn Bank, one off Angmagssalik, and one north of Angmagssalik (66°48′N., 24°57′W.).

Especially interesting is the recapture of one cod tagged with a hydrostatic tag (Lea tag). This fish, which measured 75 cm., was caught on 12. June on Fylla Bank (63°56′N., 52°32′W.). It had been tagged on 5. August 1949, in the harbour of Umanak (70°40′N., 52°05′W.), when it was only 20 cm. long. This is the fifth recapture of cod from the tagging experiment in the harbour of Umanak. This experiment was carried out in the period from 1. to 6. August 1949. A total number of 130 small cod of 16—29 cm. length were tagged. All the tagged small cod belonged no doubt to the 1947 year-class, which had an exceptionally northern distribution as groups I and II. The five recaptures from the experiment are from the years 1950, 1952, 1953, 1954, and 1957. The first recapture, in 1950, was made near the place of tagging. The remaining four were distributed over Store Hellefiske Bank, 30. August 1952, 26. July 1954, and Fylla Bank, 11. August 1953, and 12. June 1957.

The two specimens of cod taken on Store Hellefiske Bank, belonged at recapture to the V- and VII-groups respectively, while the recaptures from the Fylla Bank belonged to the VI- and X-groups. When tagged, they measured 20, 19, 24, and 20 cm., respectively. The total lengths reported at recapture for three of the fish do not, unfortunately, look sufficiently reliable. The recapture from 1957 is stated to be 75 cm., which would seem correct for a cod belonging to the X-group.

The distance between the place of tagging and the place of recapture on Store Hellefiske Bank was between 200 and 250 nautical miles, and the fish recaptured on Fylla Bank had migrated a distance of about 450 miles.

The experiment is interesting in that it shows it to be possible to tag quite small cod about 20 cm. long with hydrostatic tags. Through this experiment we have also learnt that the stock of cod

Table 8. Marked cod recaptured at Greenland (Gr.) and at Iceland (Ic.) in 1957, tabulated according to age and year of liberation

Year-class	Age-group	1948 Gr.	1948 Ic.	1949 Gr.	1949 Ic.	1950 Gr.	1950 Ic.	1951 Gr.	1951 Ic.	1952 Gr.	1952 Ic.	1953 Gr.	1953 Ic.	1954 Gr.	1954 Ic.	1955 Gr.	1955 Ic.	1956 Gr.	1956 Ic.	1957 Gr.	1957 Ic.	Total Gr.	Total %	Total Ic.
1939	XVIII	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	0.3	—
1940	XVII	2	—	—	—	—	—	—	—	—	—	—	—	1	—	3	—	—	—	1	—	7	1.9	—
1941	XVI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1942	XV	—	—	—	—	—	—	1	—	—	—	—	—	6	—	4	—	3	—	1	—	15	4.0	—
1943	XIV	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	2	—	4	1.1	—
1944	XIII	—	—	—	—	—	—	—	—	—	—	—	—	1	—	2	—	—	—	—	—	3	0.8	—
1945	XII	—	—	—	1	—	—	—	1	—	1	2	—	4	4[2]	9	—	9	—	3	—	27	7.2	7[2]
1946	XI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	1	—	5	1.3	—
1947	X	—	—	1	—	—	—	1	—	6	—	4	—	30	2	14	—	50	—	11	—	117	31.3	2
1948	IX	—	—	—	—	—	—	—	—	—	—	—	—	2	—	4	—	14	—	4	—	24	6.4	—
1949	VIII	—	—	—	—	—	—	—	1[1]	—	—	—	—	4	—	5	1	7	—	—	—	16	4.3	2[1]
1950	VII	—	—	—	—	—	—	—	—	—	—	1	—	7	—	20	—	41	1	8	—	77	20.6	1
1951	VI	—	—	—	—	—	—	—	—	—	—	—	—	1	—	3	—	13	—	5	—	22	5.9	—
1952	V	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7	—	5	—	10	—	22	5.9	—
1953	IV	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	25	—	27	7.2	—
1954	III	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—	5	1.3	—
1955	II	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	2	0.5	—
??		1	—	2	—	1	—	3	1	10	2	8	—	32	—	46	2[3]	148	1	72	—	324	—	6[3]
Total number		3	—	3	1	1	—	5	3[1]	16	3	15	—	88	6[2]	119	3[3]	297	2	150	—	697	—	18[1][2][3]

[1]) One cod recaptured at Angmagssalik. [2]) One cod recaptured on the Anton Dohrn Bank and one cod recaptured in the Denmark Strait. [3]) Two cod recaptured on the Grand Bank.

caught on the banks in Davis Strait may in certain years be recruited to a fairly great extent from cod growing up north of the regions where fishery is operated.

On 9. July a cod was caught on Store Hellefiske Bank which had been tagged with hydrostatic tag on 21. July 1950 in the harbour of Christianshåb (68°50'N., 51°00'W.). When tagged, it measured 27 cm., its length at recapture was reported to be 75 cm. The distance between the place of tagging and the place of recapture was about 120 nautical miles.

On 5. May a cod was caught in trawl off Frederikshåb (61°50'N., 50°30'W.) which had been tagged with a hydrostatic tag on 8. August 1949, off Qutdligssat (70°N., 53°W.). The distance between the place of tagging and the place of recapture was ca. 480 nautical miles. When tagged, the cod measured 47 cm., when recaptured it measured 83 cm. Judging by the measurements it no doubt belonged to the 1945 year-class.

A total of 385 otoliths of recaptured cod was taken.

Of 12 cod recaptured in other waters than West Greenland whose age it was possible to determine, 7 belonged to the XII-group (1945 year-class), 2 to the X-group (1947 year-class), 2 to the VIII-group (1949 year-class) and 1 to the VII-group (1950 year-class). Otoliths of 373 cod recaptured in West Greenland waters were taken. An age analysis of these cod showed that the 1947 year-class was continuously predominant (31.3%), while the 1950 year-class was the next in order (20.6%).

Table 9 shows the number of recaptures of tagged cod reported from the different nations. As in previous years, Portugal reported the greatest number of recaptures in Greenland waters, viz., no less than 73%. Second in order were the Greenlanders with ca. 19%, while the recaptures made by all the other nations combined constitute only ca. 8%.

Table 9. Cod recaptured in 1957

	Greenland	Iceland	Other areas	
Denmark	3	—	—	
Greenland ...	132	—	—	
Faroe Islands .	4	—	—	
Norway	4	—	—	
Iceland	8	13	—	
United Kingdom ..	6	—	—	
France	5	—	—	
Germany	6	—	3	(off East Greenland)
USSR	1	—	—	
Spain	19	—	—	
Portugal	509	—	2	(Grand Banks)
Total	697	13	5	

PAUL M. HANSEN

Icelandic Cod Investigations in South-West and South-East Greenland Waters, 1957

(Figures 8-9; Tables 10-12)

1. Introduction

In 1949 the first Icelandic trawler carried out successful fishing on the West Greenland banks. However, Icelandic trawl fishery did not start in these waters until 1951, when Icelandic trawlers made 28 trips to the West Greenland banks. In 1952 the number of trips was increased to 72, but in 1956 only 40 trips were made.

The catches almost entirely consisted of cod and redfish. The greatest part of the cod is salted and the redfish is iced for fillets or processed for fishmeal.

In recent years our efforts have more and more been directed at the very little known East Greenland area. Chartered trawlers under the supervision of our fisheries biologists have searched this area and a number of new fishing banks have already been located.

The present paper deals with the material of cod collected from the south-west and south-east coasts of Greenland in 1957. The first cruise was made by the trawler "Hallveig Fróðadottir" to the West Greenland banks during the period 17. April to 9. May. This was an ordinary fishing trip, with the object of fishing in this area at an earlier date than hitherto. The other two cruises were made to the east coast of Greenland with the trawler "Brimnes", the first one from 15. May to 1. June and the second from 19. June to 4. July. The main purpose of these cruises was to locate new redfish banks and the programme was drawn up accordingly. The catches of cod therefore cannot be said to be quite representative and in fact they were small at most of the stations.

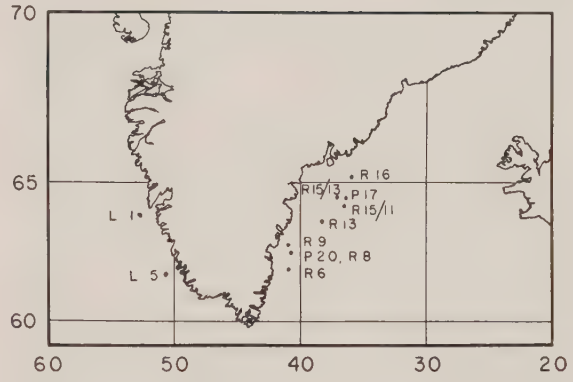

Figure 8. Location of samples taken in 1957.

Figure 8 shows the location of the samples.

Table 10. Greenland stock of cod in 1957
Age distribution and length

Station No.	L 57–1		L 57–5		R 57–6/4–5		R 57–8/1–2		R 57–9/2		R 57–13/1		R 57–15/11		R 57–15/13		R 57–16/3	
Position	64°00′N., 53°00′W.		61°47′N., 50°37′W.		61°58′N., 40°55′W.		62°30′N., 40°33′W.		62°36′N., 40°55′W.		63°40′N., 38°15′W.		64°20′N., 36°20′W.		64°30′N., 37°03′W.		65°04′N. 36°00′W.	
Date	23–25/4		1–2/5		23/6		25/6		25/6		26/6		28/6		29/6		29/6	
°C./m.	1.49°/120		3.28°/175		4.58°/300		4.32°/215		3.22°/195		4.41°/230		4.52°/290		4.88°/273		4.00°/173	
Age-group	‰	cm.	‰	cm.	‰	cm.	‰	cm.	‰	cm.	‰	cm.	‰	cm.	‰	cm.	‰	cm.
I	—	—	—	—	—	—	—	—	—	—	—	—	—	—	37	14.0	—	—
II	—	—	—	—	—	—	—	—	8	23.0	—	—	—	—	537	29.1	9	30.0
III	13	36.0	—	—	—	—	—	—	8	24.0	—	—	117	42.7	278	35.3	187	39.3
IV	379	45.4	13	47.0	—	—	7	41.0	80	41.0	—	—	133	48.3	111	43.3	56	44.3
V	168	54.7	50	56.7	—	—	22	58.7	320	46.0	17	55.0	109	53.4	19	39.0	56	56.3
VI	91	61.2	97	61.3	20	56.0	66	62.2	296	49.8	17	75.0	70	60.6	19	46.0	103	65.8
VII	232	67.2	470	66.8	61	67.0	453	68.5	224	57.3	117	79.0	219	70.8	—	—	346	72.8
VIII	23	78.4	223	72.3	102	71.4	197	81.2	24	74.3	383	85.7	156	77.4	—	—	150	81.1
IX	34	74.8	33	76.3	102	82.6	51	80.9	8	66.0	167	90.4	47	78.3	—	—	19	87.0
X	34	76.8	67	77.5	184	77.3	44	86.3	16	72.7	100	82.4	70	75.4	—	—	47	88.4
XI	7	77.0	13	76.7	20	84.0	22	89.7	8	75.0	100	88.7	16	77.0	—	—	—	—
XII	7	85.5	27	79.3	306	96.9	58	92.6	—	—	50	96.7	55	84.4	—	—	19	86.5
XIII	—	—	—	—	—	—	15	98.5	—	—	17	92.0	—	—	—	—	—	—
XIV	—	—	—	—	20	99.0	29	109.3	—	—	33	88.5	—	—	—	—	—	—
XV	—	—	—	—	122	99.2	15	108.0	16	90.0	—	—	—	—	—	—	—	—
XVI	—	—	3	100.0	—	—	15	123.0	—	—	—	—	—	—	—	—	9	91.0
XVII ...	3	91.0	—	—	20	131.0	7	106.0	—	—	—	—	8	108.0	—	—	—	—
XVIII ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
XIX	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
XX	—	—	—	—	—	—	7	106.0	—	—	—	—	—	—	—	—	—	—
XXI	—	—	—	—	20	90.0	15	129.0	—	—	—	—	—	—	—	—	—	—
XXII ...	—	—	—	—	20	131.0	—	—	—	—	—	—	—	—	—	—	—	—
Total ...	298		300		49		137		125		60		128		54		107	

2. Age distribution

The age distribution and the average lengths of the age-groups are listed in Table 10. Three predominant year-classes occur on the west coast, viz., those from 1949, 1950, and 1953. The 1953 and 1950 year-classes provide the main bulk of the catches on Fylla Bank, but on the Nameless Bank (so called by Icelandic fishermen) the 1950 and 1949 classes predominate. The two strong year-classes, 1945 and 1947, were found in very small numbers only. On the other hand, these two year-classes are relatively well represented among the mature fish on the east coast. The 1950 year-class is predominant in four out of seven samples from the east coast, especially from places where the fishing was good. This year-class therefore seems to be the predominant one in the area. In 1956 it was also abundant in the Icelandic catches from the west coast of Greenland.

3. Spawning and sexual maturity

Spawning cod was found at all stations, except one, as can be seen from Table 12. On Fylla Bank about 50% of the mature fish were actually spawning and 38% had already spawned. The otoliths have all been read with regard to the spawning zones (see Table 11) which show that about 50% of the spawning stock on Fylla Bank consisted of first-time spawners belonging to the 1950 year-class. The total number of first-time spawners in both samples from the west coast is very high, about 80%. This may be explained by the young year-classes or it may indicate that the samples are taken at the end of the spawning season, when the recruit spawners are always predominating which, at least, is the case on the Icelandic spawning grounds. These samples represent by no means a pure spawning population, as 58% of the fish on Fylla Bank were immature and 43% on the Nameless Bank. This is a much higher admixture of immature fish than found on the Icelandic spawning grounds.

On the east coast the percentage of immature fish is higher than on the west coast, except in the samples P-17/3 and P-20/13 which were taken in late May and mainly consisted of spawning fish or fish which had just spawned. Table 12 shows that spawning is going on both in May and June and probably already starts in April or earlier, and fish with maturing gonads were found as late as 29. June (Station R-16/3).

The bottom temperatures at the stations off the east coast were mostly between 4° and 5°C.

Table 11. Spawning stock of cod in Greenland waters in 1957

L 57–1

Age at first spawning

Age-groups	5	6	7	8	9	10	11	12	Total
V	16	—	—	—	—	—	—	—	16
VI	—	15	—	—	—	—	—	—	15
VII	—	2	61	—	—	—	—	—	63
VIII	—	1	1	4	—	—	—	—	6
IX	—	—	1	4	4	—	—	—	9
X	—	1	1	3	2	3	—	—	10
XI	—	—	—	1	—	—	—	—	1
XII	—	—	—	—	—	—	—	1	1
XVII	—	—	—	—	—	—	1	—	1
Total	16	19	64	12	6	3	1	1	122

R 57–6/4–5

Age at first spawning

Age-groups	6	7	8	9	10	11	12	Total
VII	—	3	—	—	—	—	—	3
VIII	1	—	4	—	—	—	—	5
IX	—	1	—	3	—	—	—	4
X	—	1	3	1	3	—	—	8
XI	—	—	—	—	—	1	—	1
XII	—	—	2	1	2	1	4	10
XV	—	1	1	—	—	—	3	5
XXI	—	—	—	1	—	—	—	1
Total	1	6	10	6	5	2	7	37

P 57–17/3

Age at first spawning

Age-groups	6	7	8	9	10	11	12	Total
VI	1	—	—	—	—	—	—	1
VII	—	4	—	—	—	—	—	4
VIII	—	—	3	—	—	—	—	3
IX	—	—	—	2	—	—	—	2
X	1	—	2	1	7	—	—	11
XI	—	—	—	1	3	—	—	4
XII	—	1	2	3	6	2	2	16
XIII	—	1	—	—	1	1	—	3
XIV	1	2	—	—	—	1	—	4
XV	—	2	3	2	1	—	—	8
XVIII	—	—	1	—	—	—	—	1
Total	3	10	11	9	18	4	2	57

R 57–8/1–2

Age at first spawning

Age-groups	6	7	8	9	10	11	12	13	Total
VI	1	—	—	—	—	—	—	—	1
VII	1	15	—	—	—	—	—	—	16
VIII	—	—	11	—	—	—	—	—	11
IX	—	2	—	1	—	—	—	—	3
X	—	1	1	—	2	—	—	—	4
XI	—	—	1	—	1	—	—	—	2
XII	—	—	1	—	2	1	1	—	5
XIII	—	—	—	—	—	—	—	1	1
XIV	—	—	—	1	1	—	2	—	4
XVI	—	—	1	1	—	—	—	—	2
XVII	—	—	—	—	—	—	1	—	1
XX	—	—	—	—	—	—	—	2	2
XXI	—	—	—	—	—	—	—	2	2
XXII	—	—	1	—	—	—	—	—	1
Total	2	18	16	3	6	1	4	5	55

Table 12. Sexual maturity of the cod in south-west and south-east Greenland waters in 1957

(For positions of stations, see Table 10)

Station No.	Immature	Maturing	Spawning	Spawned
L 57–1.....	171	14	55	43
L 57–5	131	3	6	157
P 57–17/3 ..	—	—	13	46
P 57–20/13 .	1	—	5	11
R 57–6/4–5 .	1	—	7	41
R 57–8/2 ...	79	2	5	53
R 57–9/2 ...	108	2	1	5
R 57–13/11 .	35	4	3	10
R 57–15/11 .	103	5	6	13
R 57–15/13 .	54	—	—	—
R 57–16/3 ..	92	3	4	8

Spawning of cod therefore seems to take place along the south-east coast of Greenland during the period from the middle of April to the middle of July at a bottom temperature of 4—5°C. The area investigated extends from 61°58′N. to 65°04′N. The depths at the stations are mostly 150—300 metres.

The cod seem to become mature at a somewhat later age on the east coast than on the west coast, as can be seen from the following table: —

	Percentage mature fish							
Area Age	5	6	7	8	9	10	11	12 years
Fylla Bank	32	56	91	86	90	100	—	—
Nameless Bank ...	7	55	48	66	80	90	75	100
R–8/1	—	10	26	46	38	83	100	—
R–13/1	—	—	29	22	30	67	100	—

In accordance with this, the mature part of the stock on the east coast is composed of older fish than on the west coast, especially the 1945 and 1947 year-classes. The 1945 year-class was mostly spawning for the third time just as found on the Icelandic spawning grounds in 1957. A portion of this year-class was already spawning for the sixth time. The 1947 year-class was mainly composed of recruit spawners, but some individuals were already spawning for the fifth time.

4. Growth

As appears from Table 10 similar growth-rates during the first seven years are found for the west and the east coast of Greenland. The five and six year-old fish are even larger on the west coast, but after the seventh year the average lengths are decidedly higher on the east coast, and the difference is much higher than can be accounted for by the two months difference in time of sampling. Figure 9 shows the average lengths of the age-groups of all the samples taken together from the west and east coasts especially, but also the lengths of the Icelandic stock of spawning cod in the period

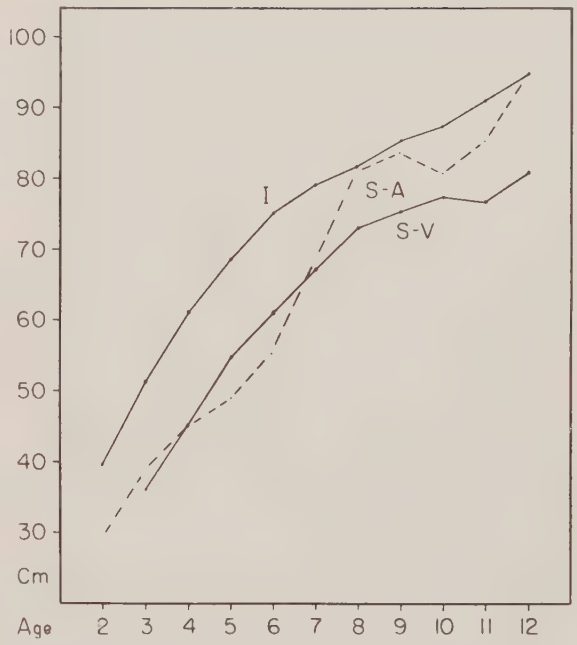

Figure 9. Average lengths of the age-groups of cod in Iceland (I), South-East Greenland (SA), and South-West Greenland (SV).

1928—1951. Comparison between the Icelandic and West Greenland stocks shows a persistent difference in length for all age-groups. If we compare the Icelandic and East Greenland stocks we also find a fairly constant difference up to age-group VIII, but for the older age-groups the average lengths are similar for the two stocks. The material from East Greenland is of course rather limited, the similarity in growth-rate is, however, very striking. It is not easy to see any reason why the older component of the East Greenland stock should suddenly start growing much faster than the West Greenland component —if it was not due to the immigration of much faster growing fish which mix with the local stock. In Icelandic waters we always notice a very sharp drop in the average length of the age-groups during a certain period in the spawning season, when the slower growing cod from the north coast mix with the faster growing fish of southern origin. This phenomenon has also been repeatedly ascertained by marking experiments.

When the cod leave the Icelandic spawning grounds a great part of the stock migrates westward and up along the west coast. Our trawlers are able to follow the shoals as far as to the western part of the north coast. The summer and autumn fishery for cod on the Icelandic shelf does not account for

the enormous quantities of spawning cod. We have therefore for a long time been suspecting it either to live pelagically or to leave the Icelandic area to a certain extent. In the East Greenland area the nearest grounds are found. The Icelandic fishery for spawning cod in the 1957 season was much less than expected. At the same time German trawlers had fairly good catches on the Anton Dohrn Bank and in other places along the East Greenland coast.

From these facts may be concluded that the fast growing cod off the East Greenland coast is either of Icelandic origin, or to an appreciable extent mixed with the fast growing Icelandic stock.

In Table 10 there is one sample, R 57-9/2, which shows a much lower growth than all the others. This station is situated on the shelf much nearer to the coast than the other stations. The depth at this station was about 190 metres and the bottom temperature 3.22°C., thus decidedly lower than at the other stations.

There seems to be a fairly close correlation between temperature and growth, if we compare St. R 57-9/2 to the other stations. We have been able to show a very distinct correlation between temperatures and the growth of the young cod in the Icelandic area and it is reasonable that this should be still more apparent here. It is a very interesting question if this station represents a slower growing population living in shallow waters, where the "Icelandic influence" is not so marked as in the stock living in the deeper and warmer waters on the slope. The otoliths of the slower growing cod are more or less of the "coastal type", with a broad first winter-ring.

5. Abundance

The cruise to the West Greenland banks was an attempt to start fishing at an earlier date than hitherto. From this point of view the trip was not quite successful. The weather was bad and ice conditions unfavourable. The trawler fished in the area from Fylla Bank to Nameless Bank. Although no hydrographical sections could be worked, measurements of the bottom temperature were made at each station. The following table gives the bottom temperatures and the catch-per-unit-effort:—

Locality	Depth fished, m.	t °C. at depth	Hours fished	Catch per hour
Fylla Bank	150–250	1.49/120–1.89/205	21.00	1.33
Fiskenes Bank	75–150	1.30/145–1.78/165	25.15	2.23
Dana Bank	150–230	1.60/215	14.00	2.39
Frederikshaab Bank	135–245	0.25/165–0.29/100	3.00	1.50
Nameless Bank	150–200	3.28/175–3.56/175	36.30	3.02

The catches were highest in the warmer waters on Nameless Bank.

As for the catches of cod on the east coast, these cannot be considered quite representative of the abundance of cod, as the programme was drawn up with regard to redfish. The catches of cod were rather poor in most places, except at St. R 57—16/1 where the catch was 1.5 tons in a 30-minute haul. At one of the stations a long-line was shot and the catch per 500 hooks was as follows: 121 cod, 5 haddock, 3 redfish, 3 torsk, 1 halibut, and 2 rays. At this station there was no catch of cod in the trawl. 121 cod per 500 hooks is a very good catch and equals the best catches on long-lines in the Icelandic fishery for spawning cod.

Jón Jónsson

German Investigations on Greenland Cod, 1957

(Figures 10–12)

West and South Greenland

In 1957 German trawlers landed 25,517 tons of cod from South and West Greenland. In contrast to the preceding year and similar to 1955 the trawlers fishing for fresh fish mostly landed redfish. The redfish season in West Greenland lasted from the middle of April to the middle of July. The proportion of cod in these catches amounted only to 4.7%.

In South Greenland the trawlers were fishing both redfish and cod from August till October. The proportion of cod was 53%. From November 1957 till the middle of February 1958 a very profitable cod fishery developed in the Cap Farewell—Sermersok—Nanortalik area, just as in 1952. The average daily output rose to 36.0 tons. Following this real cod fishery in South Greenland waters, which was stopped by advancing ice, the trawlers started a new redfish season (including small catches of cod) on the slopes of Fylla Bank in March 1958. Thus, for the first time the German fresh-fish trawlers were fishing in West and South Greenland throughout the year without interruption.

Besides this fishery for iced fish 9 trawlers were salting cod from the beginning of May until 10. August. In the beginning these trawlers operated on the western banks but, since the end of July, on the Nanortalik Bank in South Greenland.

Otoliths and length measurements from six trawler landings were used for the investigation of the cod stock, together with nine samples of ungutted cod. More than 15,000 measurements were carried out on board the R/V "Anton Dohrn"

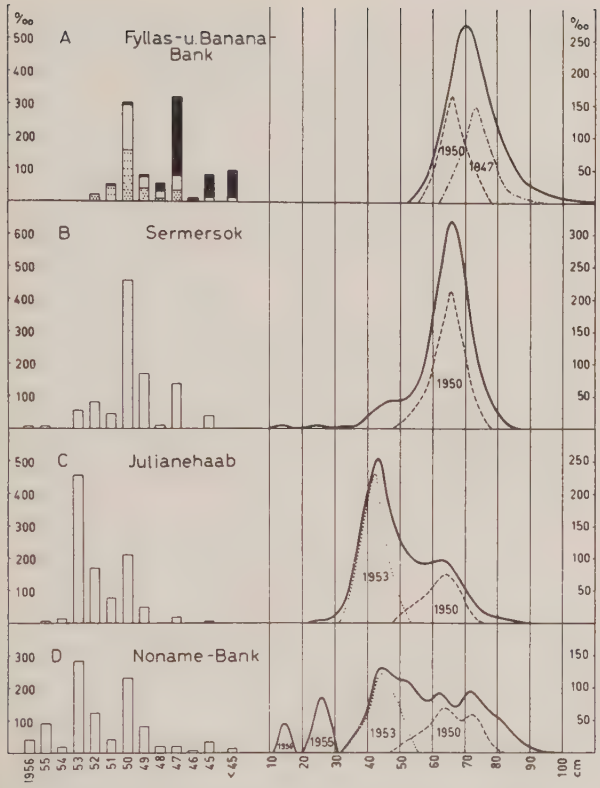

Figure 10. Age and length composition (‰) of cod in West and South Greenland. The length distribution of various important year-classes is included in the length curve for the total catch.

(A) Catch from fresh-fish trawlers in May and June on Fylla and Banana Banks.

Dotted column = immature cod

White column = first-time spawners

Black column = cod spawned several times

(B) Catch with covered cod-end made by "Anton Dohrn" off Sermersok.

(C) Catch with covered cod-end made by "Anton Dohrn" in Julianehaab Bay.

(D) Catch with covered cod-end made by "Anton Dohrn" on Noname Bank.

operating in August 1957 in South and West Greenland waters with net selection tests.

Figure 10 A shows the length and age composition of the cod fished commercially on the slopes of Fylla and Banana Banks in May and June. As in the preceding year the 1947 (31.9%) and 1950 (30.2%) year-classes were again predominant; 33% of all cod were immature, 27% had just spawned in spring 1957 for the first time, and 40% had spawned twice and more. The distribution of the mature and immature fish of the different year-classes is also shown in Figure 10 A. Of the rich 1950 year-class 53% were still immature, 45% were first-time spawners, and 2% had spawned for the second time. Of the 1947 year-class 10% were still immature, 14% were first-time spawners, and 76% had spawned two, three, or four times. It is interesting to note that 14% of the 12 year-old cod were still immature.

In 1957 no rich, young year-class joined the marketable stock. Therefore the average age and length rose above normal, namely during the last 3 years from 68.7 cm. (1955) and 69.1 cm. (1956) to 73.3 cm. (1957). The 7 year-old cod measured 67.1 cm., those 10 years old, 72.8 cm.

In South Greenland (Figure 10 B) the age composition resembles more that of East Greenland than that of West Greenland. As in 1956 the 1950 year-class was by far predominant, providing 51.7% (1956: 53.1%). Next in strength followed that of 1949 with 18.3%, which during all the preceding years was observed to be stronger in the south than in the west and which is very strong in East Greenland. The 1947 year-class is only of small commercial value in South Greenland. The 1945 year-class, up to 1955 of great importance, especially in South Greenland, was only represented by a few specimens. The average length of all cod (66.5 cm.) was considerably lower than in West Greenland. But the quality of the South Greenland winter cod is far above that of the lean cod of West Greenland early in summer. The average length of the 1950 year-class in South Greenland was 65.8 cm., and the cod born in 1949 measured 70.6 cm. at the end of the feeding period.

The experimental fishing by "Anton Dohrn" with covered cod-end mostly in the area of Sermersok and in Julianehaab Bay, 25 miles S.E. of Cape Thorvaldsen, enabled us to estimate the real length and age composition of all cod present in these localities.

In the area 20 miles S.W. of the southern tip of Sermersok at a depth of 125 m. the age and length composition of the total stock of cod fished with narrow meshes (Fig. 10 B) was rather equal to that of the cod fished by the commercial trawlers using 110 mm. meshes in the Cape Farewell-Sermersok-Nanortalik Bank area. Thus in these places almost all cod present are of marketable size. When fishing with meshes of 110 mm. only 5% of the fish were below 50 cm. and they were rejected at sea. In the Bay of Julianehaab, however, the stock of cod was composed of far younger fish (Fig. 10 C). Here the new strong 1953 year-class, which will make its first entry into the fishery in 1958, occurred in large shoals. These 4 year-old cod made up

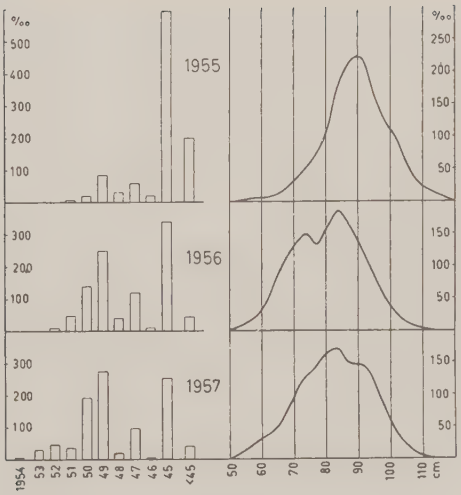

Figure 11. Age and length composition (‰) of cod caught on the Dohrn Bank in autumn 1955 (X–XI), 1956 (IX), and 1957 (IX–XII).

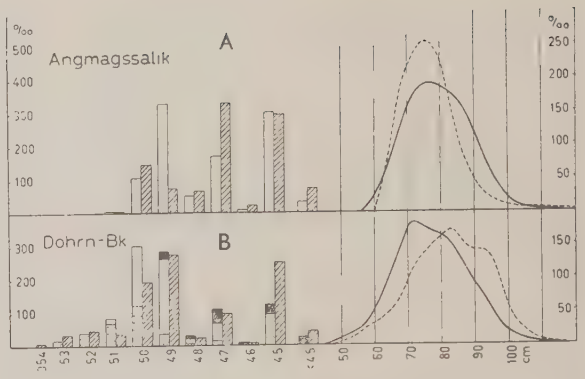

Figure 12. Age and length composition (‰) of cod caught (A) off Angmagssalik in March 1957 (continuous line) and April 1957 (stippled line); (B) on the Dohrn Bank in spring 1957 (continuous line) and autumn and early winter 1957 (stippled line).

Hatched column = immature cod
White column = first-time spawners
Black column = cod spawned several times

45.6% and had in August attained an average length of 41.8 cm. The second strongest year-class was that of 1950 (20.7%) with an average length of 60.8 cm. In this part of South Greenland the stock of cod is composed of smaller fish and, accordingly, the trawlers only trawl for redfish.

The "Anton Dohrn" was fishing with covered cod-end also on the western edge of Noname Bank at a depth of 120—130 m. Figure 10 D shows that here also younger cod were plentiful, especially the rich 1953 year-class. But as a whole the catch in this locality was poor.

East Greenland

In 1957 German trawlers made 135 trips only to East Greenland. The landings dropped from 46,067 tons in 1955 and 44,683 tons in 1956 to 21,804 tons in 1957. This decrease was due to smaller catches of redfish. Thus the cod became more and more important and the yield increased proportionately from 6.5% in 1955 and 16.6% in 1956 to 26.8% in 1957. Cod was mostly fished on the Dohrn Bank, especially in April and May. During these months the catches of cod often far exceeded those of redfish.

From a good many samples of cod taken almost throughout the year from commercial trawlers as well as from catches made by the "Anton Dohrn" the impression was intensified, that after the establishment of a real self-containing West Greenland stock of cod with a typical migration pattern (see RASMUSSEN below) we now encounter a second Greenland cod stock of Icelandic origin, a fact which must be ascribed to the heating of the Greenland waters. This stock spawns, according to our experience from the spring of 1956, 1957, and 1958, and research carried out by JÓN JÓNSSON in 1957, along the edge of the eastern and south-eastern Greenland shelf. The brood grows up partly in East Greenland and partly in south and south-western Greenland waters. Besides this real East Greenland stock another population exists in the same waters, born in Iceland and as brood drifted to East and South Greenland, growing up there and later on returning to Iceland for spawning. It is possible by tagging experiments to prove it a feeding migration to East Greenland during summer and autumn of mature Icelandic cod also takes place.

As in 1955 and 1956, the three year-classes of 1945, 1947, and 1949 also in 1957 constituted the major part of the population on the German fishing places, the Dohrn Bank and at Angmagssalik. However, during these three years the proportion of the 1945 year-class has dropped considerably, while that of the 1949 class has risen. The new 1950 year-class, entering the fishery in 1956, was more plentiful on the Dohrn Bank than on the Angmagssalik fishing grounds (see Fig. 11).

The age composition of the single samples varies considerably, even when taken at the same locality within short intervals. This phenomenon is especially observed in spring when the cod is spawning or nearly ready for spawning. This variation in age composition must be interpreted as an indication of spawning migrations to East Greenlandic as well as to Icelandic spawning places.

In April 1957 the fishery at Angmagssalik ceased and was shifted to the Dohrn Bank where we noticed a similar variation in age composition as in the preceding year. In April 1956 the majority of the 1945 year-class left Angmagssalik (see Ann. Biol., 13), in April 1957, however, the 1949 year-class did the same and in both cases the proportion of the 1947 year-class rose considerably. Furthermore, in both years the mean length of these year-classes decreased, together with the average length of all cod fished. This sudden decline in length was very obvious in 1957 because, while the average length dropped from 79.2 cm. to 76.7 cm. the average age rose from 9.7 to 10.6 years. This change in the age/length key from March to April indicated that the faster growing cod, probably of Icelandic origin, had left Angmagssalik for spawning while the slower growing East Greenland cod remained in the same locality (see Fig. 12).

The presence of the faster growing Icelandic cod on the East Greenland fishing places near Iceland becomes also evident when we compare the average length of the cod fished on the Dohrn Bank (30°W.) to that fished at Angmagssalik (35°30'W.). From February to May 1957 the mean lengths of the four outstanding year-classes of 1950, 1949, 1947, and 1945 present on the Dohrn Bank were 73.3, 78.3, 80.7, and 88.5 cm. respectively, and at Angmagssalik they were 70.3, 76.2, 78.7, and 85.1 cm. respectively.

In Figure 12 is also shown the distribution of maturity on the Dohrn Bank in spring 1957 of the different year-classes according to samples of ungutted cod. Of all cod 30.5% were immature, 56.0% were first-time spawners, or about to spawn for the first time, and 13.5% were ripening or spawning for the second time or more. In previous reports the interesting fact has been mentioned that many of the largest East Greenland cod were immature. In 1957 there were still 17% among the 12 year-old cod of the rich 1945 year-class which had never spawned, and 57% were first-time spawners. On the other hand, 22% of the young 1951 year-class had already reached maturity.

From samples of cod taken in autumn and early winter it is seen that in the second half of the year far larger cod are present on the Dohrn Bank than during the period of spawning and spawning migration. The percentage of cod older than 10 years was far higher in autumn (29.8%) than in spring (14.6%). The average length of the four year-classes of 1950, 1949, 1947, and 1945 had risen from 73.6, 78.3, 80.7, and 88.5 cm. in spring to 77.1, 80.6, 85.9, and 91.9 cm. in autumn.

Arno Meyer

Norwegian Investigations at West Greenland

(Tables 13–15)

Table 13. Age composition of different fishing gears, 1956

Age (years)	Bottom long-line Total	Floating long-line Holsteinsborg Deep	Hand-line Holsteinsborg Deep, shallow	Purse-seine Holsteinsborg Deep	Purse-seine Cape Farewell	Total, all gears and localities
	%	%	%	%	%	%
4	1.3	—	3.6	9.1	—	1.6
5	3.5	2.5	10.9	21.2	—	4.7
6	10.8	18.2	34.3	30.3	4.0	15.5
7	5.5	0.5	4.0	3.0	7.3	4.7
8	7.8	12.3	10.9	3.0	6.5	8.7
9	26.1	31.4	24.6	24.2	20.2	26.0
10	8.6	6.9	2.8	3.0	8.9	7.3
11	7.3	6.9	3.2	—	34.7	8.6
12	3.1	3.0	0.4	—	5.6	2.8
13	5.9	5.9	2.8	—	2.4	5.0
14	12.4	8.4	1.6	6.1	7.3	9.6
15	2.1	2.5	0.8	—	0.8	1.8
16	1.2	0.5	—	—	0.8	0.8
17	1.3	0.5	—	—	0.8	0.9
18	0.2	—	—	—	—	0.1
19	—	0.5	—	—	—	0.1
20	1.0	—	—	—	0.8	0.7
21	0.8	—	—	—	—	0.5
22	0.9	—	—	—	—	0.5
23	0.1	—	—	—	—	0.1
24	0.1	—	—	—	—	0.1
Total	931	203	248	33	124	1539
Mean age	10.1	9.4	7.5	7.0	10.3	9.6

Table 14. Length distribution of cod from different fishing gears, 1956

Length, cm.	Bottom long-line Total	Floating long-line Holsteinsborg Deep	Hand-line Holsteinsborg Deep	Purse-seine Holsteinsborg Deep	Purse-seine Cape Farewell	Total, all gears and localities
	%	%	%	%	%	%
45	1.2	—	1.6	6.0	—	1.1
50	1.8	—	3.6	6.0	—	1.8
55	3.6	4.4	10.9	24.2	—	5.0
60	6.8	9.4	22.6	9.1	4.8	9.6
65	11.4	14.8	17.3	15.3	16.1	13.2
70	18.3	21.7	17.3	9.1	17.7	18.3
75	20.4	24.6	13.6	21.2	16.9	19.8
80	15.5	15.3	8.5	6.0	18.5	14.3
85	8.7	8.4	3.2	3.0	17.7	8.4
90	4.6	1.5	0.8	—	5.6	3.6
95	2.3	—	—	—	2.4	1.6
100	2.5	—	0.8	—	—	1.6
105	1.5	—	—	—	—	0.9
110	0.6	—	—	—	—	0.4
115	0.2	—	—	—	—	0.1
120	0.2	—	—	—	—	0.1
125	0.1	—	—	—	—	0.1
130	—	—	—	—	—	—
135	—	—	—	—	—	—
140	—	—	—			—
145	0.1	—	—	—	—	0.1
Total number of fish	931	203	248	33	124	1539
Aver. length, cm. .	74.81	71.98	66.53	64.09	75.81	72.92

Table 15. Age and length distribution of cod caught with hand-lines in Holsteinsborg Deep, August 1957

	Age (years)													
Length, cm.	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
50— 54	1	1	—	—	—	—	—	—	—	—	—	—	—	2
55— 59	2	7	4	—	—	—	—	—	—	—	—	—	—	13
60— 64	1	26	25	3	—	—	—	—	—	—	—	—	—	55
65— 69	—	7	45	62	3	5	4	—	—	—	—	—	—	126
70— 74	—	—	19	117	12	36	79	3	3	1	—	—	—	270
75— 79	—	—	—	66	19	56	150	15	11	1	2	1	—	321
80— 84	—	—	1	7	16	23	115	14	19	5	4	5	1	210
85— 89	—	—	—	1	3	5	18	9	12	5	3	7	2	65
90— 94	—	—	—	—	2	2	3	0	10	1	1	2	2	22
95— 99	—	—	—	—	—	—	2	—	1	—	1	—	—	4
100—104	—	—	—	—	—	—	—	—	1	—	—	—	1	2
105—109	—	—	—	—	—	—	—	—	1	—	—	—	—	1
Total	4	41	94	256	55	127	371	41	58	13	11	15	6	1,091

B. Rasmussen

Table 16. Recaptures of tagged cod in West Greenland from the tagging years 1953–1956

	Degrees North Latitude											
	61–62	62–63	63–64	64–65	65–66	66–67	67–68	68–69	69–70	To Iceland	To Newfld.	Total
March	—	—	—	—	—	—	—	—	—	1	—	1
April	—	—	—	—	—	—	—	—	—	5	1	6
May	2	7	6	8	—	—	—	—	—	1	—	24
June	—	17	20	20	12	6	—	1	—	—	—	76
July	—	1	6	3	2	6	9	3	—	—	—	30
August	—	—	1	1	1	29	24	2	2	—	—	60
September	—	—	—	—	—	16	6	1	—	—	—	23
October	—	1	—	1	—	2	1	2	—	—	—	7
Total	2	26	33	33	15	59	40	9	2	7	1	227

On the Migration Pattern of the West Greenland Stock of Cod

(Figure 13; Tables 16–17)

During a period of 5 years from 1953 to 1957 a cod tagging programme has been carried out in West Greenland waters. All the taggings in these years have been performed in one and the same locality, namely in the Holsteinsborg Deep situated between Store Hellefiske Bank and Lille Hellefiske Bank. The recaptures from these taggings, hitherto recorded, have given a very clear picture of the seasonal migrations of the West Greenland cod stock. The recaptures from year to year give an almost identical picture of the migration pattern. In the present paper the results of 1956 taggings will be dealt with as a proper example.

From the 1956 marking experiments in West Greenland waters we have received altogether 59 recaptures out of 491 taggings, i.e., 12%. The locality of recaptures is shown in Figure 13. The recaptures made during the same season show a decided northward migration during late summer and autumn. In winter the cod undertake a southward spawning migration to the Frederikshåb, Dana, Fiskenaes, and Fylla Banks. According to the fishermen, the southward migration route is over the more shallow parts of the banks. On the southern banks, mentioned above, we have recaptures of spent fish in May and June, and also a few from July. Later in the season recaptures are made further north. According to the fishermen, this northward migration has a course along the slopes of the banks. The recaptures from the 1956 taggings confirm the picture of seasonal movement of the West Greenland cod, indicated by earlier taggings, namely a southward spawning migration to about 62°N. Lat. in winter, and a northward feeding migration in summer to 68° or 70° N. Lat.

In order to illustrate further the movement of the West Greenland cod the recaptures from the marking experiments 1953—1956 are recorded as to date and latitude in Table 16. From these taggings a total of 227 tags has been returned with information as to exact position and date. As indicated by the table there obviously is a correlation between date of recapture and latitude where caught. In May and June most recaptures are registered from the southern banks with a maximum around 63°—65°N. Lat. In August—September the majority of the recaptures are made in 66°—68°N. Lat. From these taggings only 7 specimens have migrated to Iceland and 1 to Newfoundland. The material indicates that the West Greenland area north of 62°N. Lat. is dominated by

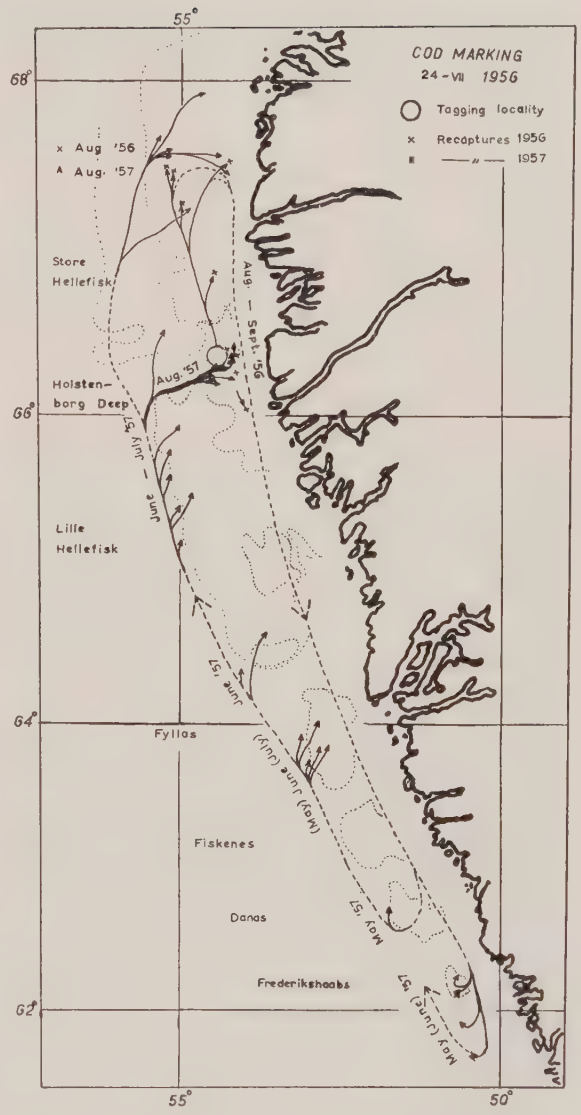

Figure 13. Migration pattern of the West Greenland stock of cod as indicated by Norwegian marking experiments.

an almost separate population of cod, with a more or less closed migration pattern. Only very few cod of this true West Greenland stock seem to migrate to Iceland. For the further study of this problem it would be of the greatest interest to perform large-scale taggings in the area south of 62° N. Lat., for example, near Cape Farewell, in order to study the migration pattern of the cod population found in that area.

Danish marking experiments have previously shown that during the 1930'ies there was a heavy migration of cod from Greenland to Iceland. Paul Hansen in his "Studies on the biology of

Table 17. Summary table of Norwegian taggings and recaptures 1948–1957 in West Greenland waters

Year of tagging	Numbers tagged	Total recaptures	% of total	Recaptures at Iceland Number	% of recaptures
1948	387	50	12.9	3	6
49	143	33	23.0	4	12.1
50	300	47	15.7	8	17.0
51	200	46	23.0	3	6.5
52	124	19	15.3	3	15.7
53	512	81	15.8	4	4.9
54	431	53	12.3	1	1.9
55	275	38	13.4	1	2.6
56	491	59	12.0	0	0
57	400	5	1.2	0	0
Total	3,263	431	13.3	27	6.3

the cod in Greenland waters" (1949) mentions that the great spawning migrations of cod to Iceland take place mainly from the southern districts, Frederikshåb and Julianehåb, where over 70% of the tagged cod were recaptured in Icelandic waters. In my opinion at least two stocks of cod are to be found in West Greenland waters, one with a distribution pattern as shown by our tagging results, the other and southern one belonging to the Icelandic or perhaps a separate or mixed East Greenland stock. Some recaptures of the true West Greenland stock are also made at present in Icelandic waters, but they are rather exceptional. During the 10 years from 1948 to 1957 the Norwegian biologists have tagged a total of 3,263 cod in West Greenland waters. Of this 431, or 13.3%, have been recaptured. Only 27, or 0.8%, of the total number of cod marked have been recaptured at Iceland.

In Table 17 are shown the details of the annual taggings. As will appear from this table, it is particularly from the taggings in 1950 and 1952 that many recaptures are made at Iceland. From Iceland we have also received otoliths of some of the recaptured fish. From the 1950 taggings of which 8 fish were taken at Iceland, age determinations are available for 4 fish. Three of these belong to the 1945 year-class while 1 belongs to the 1946 year-class. Of the 3 recaptures from the 1952 taggings taken at Iceland, 2 belong to the 1945 year-class and 1 to the 1946 year-class.

In West Greenland waters the 1945 year-class has been of no importance to the Norwegian long-line fishery mainly carried out on the bank slopes north of 62°N. Lat. This is probably a year-class not belonging to the true West Greenland stock, but only visitors on a feeding migration. This may be the reason for the heavy emigration to Iceland of this particular year-class upon reaching the age of maturity in 1954—56. As regards the 1947 year-class which apparently belongs to the true West Greenland stock, not a single individual of this class has as yet been returned from Iceland. Many individuals belonging to the 1947 class have been tagged in the Holsteinsborg Deep. Thus in 1954 we tagged 431 fish at this locality of which 30.5 per cent. belonged to the 1947 year-class according to the samples taken simultaneously. Although we have received a recapture from Iceland from the 1954 tagging this specimen belonged to the 1945 year-class. Our tagging experiments show no indication of a large-scale emigration from Greenland of the 1947 year-class.

BIRGER RASMUSSEN

Iceland Stock

The Spawning Stock of Cod in 1957

(Table 18)

Table 18 shows the age distribution of the spawning stock of cod in 1957. The table is based upon samples of cod caught by long-line in the south-western waters of Iceland during the months January to May and calculated in 10,000 as in previous years. The column to the right shows the forecast for 1957, made in 1956.

As was expected, the stock was mainly composed of the 1945 and 1949 year-classes and the prediction for these turned out to be quite right. This fact is mentioned here because the prediction for the 1945 year-class in previous years has been rather disappointing, the actual values being much higher than those expected. A possible explanation for this is the fact that there has been a considerable migration of this year-class from Greenland to the Icelandic spawning grounds in recent years. The good agreement in 1957 between the predicted and the actual values might indicate that the migration is not so extensive any longer.

According to Dr. PAUL HANSEN there were in 1955 33 recaptures of cod, belonging to the 1945 year-class, from the marking experiments performed at West Greenland during the years 1949 to 1953. Of these recaptures 15, or 45.5%, were taken at Iceland. In 1956 there were 35 recaptures from marking experiments carried out in the period 1949 to 1954, but only 10 of these, or 28.6%, were recovered in Icelandic waters. However, these figures seem to indicate a considerable drop in the migration in 1956.

JÓN JÓNSSON

Table 18. Icelandic spawning of cod, 1957

Age-groups	Age at first spawning 3	4	5	6	7	8	9	10	11	12	13	Total	Prediction for 1957
III	5	—	—	—	—	—	—	—	—	—	—	5	—
IV	—	5	—	—	—	—	—	—	—	—	—	5	—
V	—	—	315	—	—	—	—	—	—	—	—	315	123
VI	—	—	5	631	—	—	—	—	—	—	—	636	405
VII	—	—	5	100	1,109	—	—	—	—	—	—	1,214	1,124
VIII	—	—	24	91	531	2,309	—	—	—	—	—	2,955	3,236
IX	—	—	—	29	91	191	382	—	—	—	—	693	614
X	—	—	—	—	48	105	172	292	—	—	—	617	477
XI	—	—	—	—	5	57	105	143	96	—	—	406	265
XII	—	—	5	10	38	258	440	793	994	315	—	2,853	3,512
XIII	—	—	—	—	10	—	14	29	43	19	—	115	128
XIV	—	—	—	5	10	19	24	10	48	19	5	140	63
XV	—	—	—	—	5	14	10	—	—	5	—	34	40
XVI	—	—	—	—	—	—	—	5	—	—	—	5	2
XVII ...	—	—	—	—	—	5	—	—	—	—	—	5	3
XVIII ..	—	—	—	—	—	—	—	—	—	—	—	—	2
XIX	—	—	—	—	—	—	—	—	—	5	—	5	3
Total ...	5	5	354	866	1,847	2,958	1,147	1,272	1,181	363	5	10,003	

	Spawning classes 1	2	3	4	5	6	7	8	9	10	Total
Number .	5,459	2,160	1,252	680	287	62	54	34	10	5	10,003

Arcto-Norwegian Stock

Soviet Investigations on Cod and Haddock

The feeding conditions of cod in the Barents Sea were outstanding in 1957 by a number of peculiar features. Thus, during the winter/spring period capelin did not approach the Murman coasts but dispersed instead along the Norwegian coast. As a result of this fact, no stable commercial concentrations of cod and haddock were observed on many of the most important Soviet fishing grounds.

During the summer of 1957 intensive feeding of cod on Euphausiacea was observed in the central Barents Sea, which was remarkable both by the great abundance of these crustaceans and the lower numbers of cod present, as compared with the previous year.

In autumn, the cod migrating to the spawning grounds and the places where they stay during the winter, were feeding mainly on young cod and herring.

In 1957, catches of cod and haddock (per one hour/day/trawler) decreased considerably in all parts of the Barents Sea, as compared with the preceding year. This was mainly a result of the decline of the stocks of these fish, produced by a considerable decrease in the numbers of older fish of the rich 1948—50 year-classes and from insufficient recruitment, especially from the young 1951—55 year-classes. An unfavourable distribution of fish in the area of fishing also added to the decline of the catches. Trawlings were undertaken mainly in the western Barents Sea where the bottom is of a hard consistency.

Regular assessments of the young commercial species are made from year to year and were repeated in the winters of 1956/57 and 1957/58. As a result of these observations the strength of certain year-classes, which are fishable at present, is ascertained as follows:—

Year-class	Cod	Haddock
1948	good	good
1949	good	good
1950	rich	very rich
1951	medium	medium
1952	poor	poor
1953	medium	good
1954	medium	poor
1955	poor	poor
1956	medium	good

Preliminary data based on the results of the first year's study show that the 1957 year-class of both cod and haddock can be considered good, according to its abundance, but it is certainly not so strong as the rich 1950 year-class.

V. I. Travin

Table 19. Percentage first-year recaptures per 5 cm. length groups

Year	30/	35/	40/	45/	50/	55/	60/	65/	70/	75/	80/	85/	90/	95/	100/	105/	110/	115/	120/	125/	13
1957[1])	34	39	44	49	54	59	64	69	74	79	84	89	94	99	104	109	114	119	124	129	13
Numbers released	8	7	8	173	348	472	559	623	582	470	243	85	30	8	8	1	4	0	1	—	
Numbers returned	—	—	—	2	9	18	24	17	15	11	10	5	0	1	—	—	—	—	—	—	
% per length group	—	—	—	1.2	2.6	3.8	4.3	2.7	2.6	2.3	4.1	5.9	0	12.5	—	—	—	—	—	—	
1956																					
Numbers released	—	—	8	23	104	181	289	316	233	115	54	25	7	6	2	2	1	0	—	—	
Numbers returned	—	—	0	2	8	23	31	34	22	9	6	4	0	1	0	1	0	0	0	—	
% per length group	—	—	—	8.7	7.7	12.7	10.7	10.8	9.4	7.8	11.1	16.0	0	16.7	—	50	—	—	—	—	
1955																					
Numbers released	—	5	32	134	494	913	738	401	272	254	155	79	58	24	24	11	6	2	1	0	
Numbers returned	—	—	—	3	15	46	42	24	16	23	7	7	6	4	5	2	0	1	—	—	
% per length group	—	—	—	2.2	3.0	5.0	5.7	6.0	5.9	9.1	4.5	8.9	10.3	16.7	20.8	18.2	—	50	—	—	

[1]) Recaptures to date (1st May).

English Cod Tagging in 1956 and 1957

(Figure 14; Table 19)

Tagging was continued by the "Ernest Holt" during 1956 and 1957 as part of the Anglo-Norwegian study of growth and mortality. In these two years 1,371 and 3,630 cod were released respectively. During 1957 monofilament nylon was abandoned for nylon "wool" and finally plaited nylon attachment loops. In the later cruises of that year plastic (P.V.C.) flag-tags were tested against the Lea tag, which had previously been the standard tag. Both tags were attached dorsally.

Release and recapture data are given in Table 19 and are arranged in 5 cm. length groups for the two years. In addition, the 1955 data, previously published in Ann. Biol. 1955, for an incomplete year, are amended. Cod tagged in 1957 have not yet completed their first year of liberty but their returns are given to 1. May 1958.

During the last six months of 1957, when most of the tagging was carried out, the rate of recapture was somewhat lower than in the corresponding period of 1956, when only a little tagging was done. Release and recapture data are given for the five "Ernest Holt" cruises concerned. (Figures show numbers released/numbers returned.)

1957	2/7–16/7	= 2,350/71
	3/9–8/9	= 637/2
	12/10–21/10	= 643/4
1956	29/5–19/6	= 574/41
	26/7–16/8	= 797/29

Furthermore, it will be seen that the size composition of the 1957 tagged population was such that larger numbers of returns might have been expected.

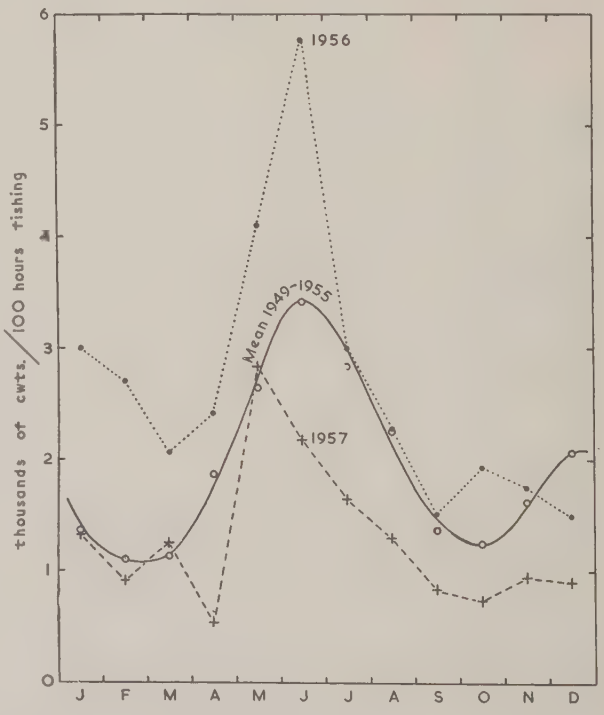

Figure 14. Comparison of catches of cod per 100 hours' fishing, Bear Island–Spitsbergen areas, 1956 and 1957.

The lower return rate during 1957 is a reflection of the lower catch per unit effort (Figure 14) and is thought to be associated with the high transport values occurring in the West Spitsbergen Current. During December 1956, transport was exceptionally high, but in May 1957, it was about average. However, most of this May transport occurred within the first ten miles of the edge of the Bear Island Bank, this is, in the region of the bank, down to some 400 metres, in which many cod spend the winter. This would mean that in this part of the West Spitsbergen Current transport and so velocity was higher than average and so would have tended to displace the cod northwards earlier than usual.

Cod were found, during the "Holt's" summer cruises, to be on grounds unusually far north—the Foreland Bank (West Spitsbergen) in May and on the Sjubre Bank (North Spitsbergen) in early July—whilst much of the fishing tended to be on the more normal summer grounds.

G. C. Trout

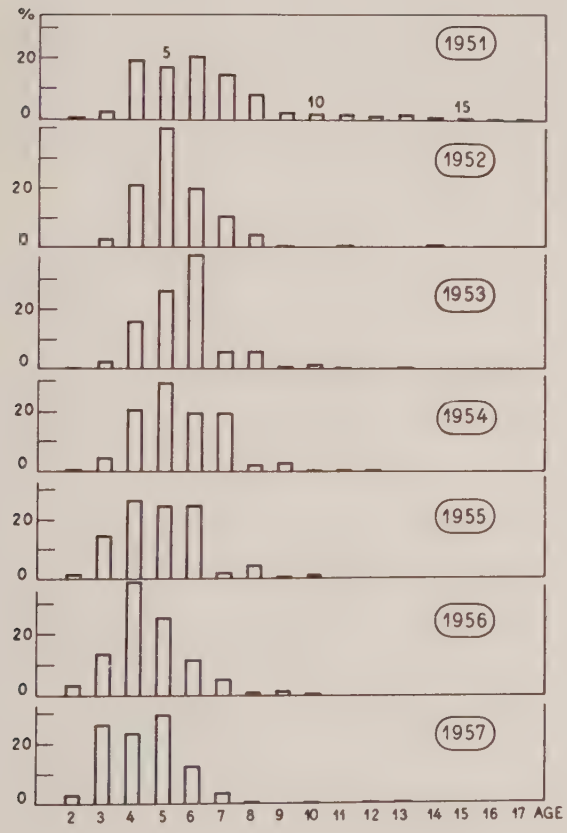

Figure 15. Age composition of spawning cod, north of the Faroes.

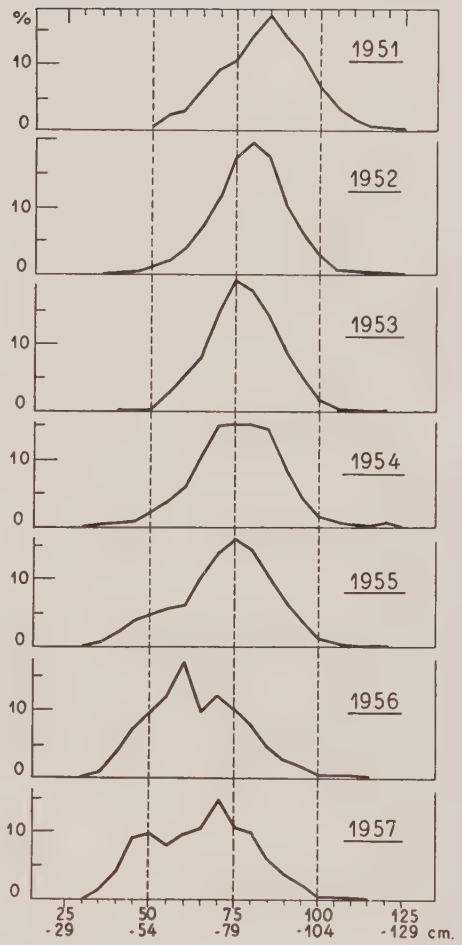

Figure 16. Length distribution of spawning cod, north of the Faroes.

Faroe Stock

Spawning Cod North of the Faroes

(Figures 15–16)

Figure 15 shows the age distribution of the cod north of the Faroes in the spring 1957 compared with the previous years. In 1957, 1,100 cod otoliths were collected from the commercial long-line fishery north of the islands. The 1952 and 1954 year-classes seem to be good. 3,300 cod from the commercial long-line fishery on the spawning grounds north of the islands were measured in 1957, and Figure 16 shows the length distribution in 1957 compared with the previous years.

J. S. Joensen

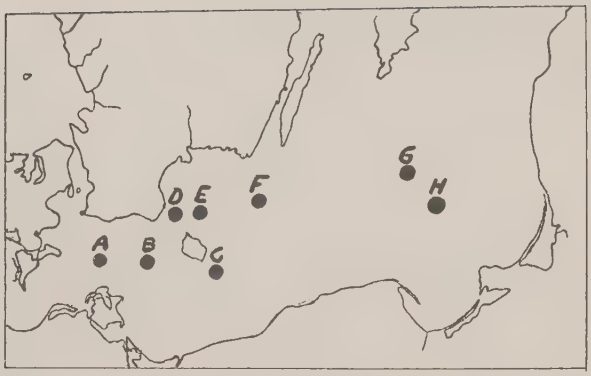

Figure 17. Positions of the main fishing localities in the southern Baltic in 1957.

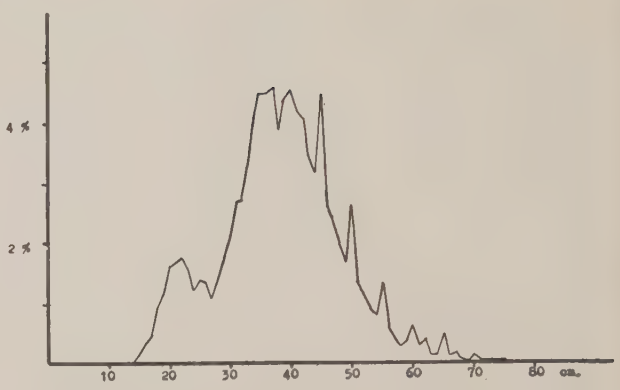

Figure 18. Length distribution of the total catch of cod caught in the southern Baltic in May–June 1957 (1 cm. groups).

Baltic Stock

Swedish Investigations

(Figures 17–18; Table 20)

In the period 20. May—19. June 1957 various trawling experiments were carried out in the southern Baltic using the covered cod-end technique. 79 hauls, normally of one hour's duration, were made in different regions. The main fishing areas are shown in Figure 17 (cf. also Table 20). The number of fish caught amounted to 15,810.

In order to retain even very small fish a cover of fine-mesh cotton net was attached to the cod-end. The number of fish belonging to the youngest age-groups were, however, insignificant in the catches. The explanation may partly be that the young fish at this time of the year were largely concentrated in other areas and in more shallow waters. In area C and D only, and to some extent in area A (cf. Fig. 17) small numbers of young fish were taken. Judging from our investigations in

Table 20. Length distribution of cod in Swedish catches

Locality	Depth m.	Date 1957	Trawling hours	Total number of fish caught	Length distribution (% per 5 cm. group) 6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75
Area A		13/6																
55°00′N., 13°20′E.	46–47	14/6 17/6	14	1,571	—	0.2	4.8	12.9	20.3	17.8	14.8	13.5	9.2	4.5	0.9	0.5	0.6	—
Area B		17/6																
55°01′N., 14°02′E.	49	18/6 19/6	9	2,037	—	—	0.3	0.7	2.7	16.9	25.7	23.1	17.2	5.8	2.5	2.8	1.5	0.8
Area C		23/5																
54°50′N., 15°15′E.	67–72	27/5 28/5	$12^1/_4$	1,871	0.3	1.4	18.1	27.0	7.7	8.7	16.4	12.5	5.8	1.2	0.6	0.3	—	—
Area D																		
55°28′N., 14°41′E.	69–73	20/5	4	416	1.2	1.4	8.6	18.0	7.5	8.7	14.5	13.0	12.2	7.0	3.6	2.4	1.9	—
Area E																		
55°29′N., 15°08′E.	76–90	21/5 22/5	$10^1/_5$	1,336	—	—	0.5	1.2	6.6	22.9	24.4	22.5	12.3	6.5	1.9	0.9	0.3	—
Area F																		
55°44′N., 16°05′E.	61–70	29/5 31/5	12	774	—	—	—	0.9	7.1	16.0	18.5	20.4	16.1	9.5	6.5	4.0	1.0	—
Area G																		
55°48′N., 18°32′E.	106–110	3/6	2	660	—	—	—	0.4	8.8	31.8	30.9	16.7	5.2	3.0	1.9	1.3	—	—
Area H																		
55°31′N., 19°06′E.	89	4/6 5/6	10	1,510	—	—	0.4	0.7	4.9	23.4	30.1	23.3	6.9	5.3	2.4	1.2	0.6	0.3

February/March 1958, the 1955 and, especially, 1956 year-classes are poor (1957 is probably rich), a fact which at least partly is responsible for the small quantities of young cod caught.

The length distributions of the catches in the main fishing localities in 1957 are demonstrated in Table 20. A diagram of the total catch is given in Figure 18 (1 cm. groups).

G. Otterlind, G. Sellerberg

Polish Investigations in 1957

(Figure 19; Table 21)

The yield of the Polish cod fishery in the southern Baltic in 1957 was quite satisfactory. More than 56,000 tons were landed. The average catch per hour's trawling increased in comparison with the averages for 1955—1956. Age-groups III and IV (9.4 and 22.5% respectively, by weight) were most numerously represented in the catches.

The good yield in 1957 may be accounted for by the strength of the 1953 and 1954 year-classes.

In 1957 an improvement in the lengths of the cod caught in the south-eastern Baltic was also noted, as shown in Table 21 and illustrated in Figure 19.

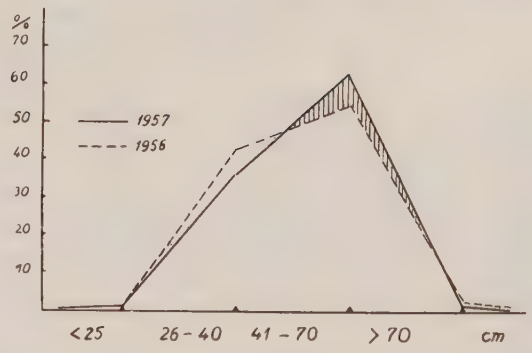

Figure 19. Percentage length distribution of cod caught in the south-eastern Baltic.

Table 21. Percentage length distribution of cod caught in the south-eastern Baltic in 1957

Year	Length, cm. 25	26–40	41–70	70
1956	0.2	42.5	54.6	2.7
1957	0.3	35.9	62.1	1.7

More large and old fish were caught. The proportion of young cod in the catches (age-groups I and II) was lower than in previous years. This fact seems to indicate that the broods of 1955 and 1956 were rather poor.

St. Rutkowicz

HADDOCK

Faroe Stock

Scottish Investigations

(Tables 22–23)

Market sampling of the Faroe haddock stock has been continued as in previous years, and the data are given in Table 22 (see next page).

Age composition

The age composition of the haddock sampled from commercial trawlers is shown in Table 22A. The mean lengths of each year-class are given in Table 22B, and in Table 22C are shown the estimated weights of each year-class landed per 10 hours' fishing each month. These were determined by converting the mean lengths in Table 22B to weights (using data from Russell, 1914[1]) and then multiplying each by the appropriate numbers per 10 hours' fishing from Table 22A.

As in previous years, the younger age-groups (II—V) made up the greater part of the landings.

[1]) Russell, E. S. (1914). Fish. Invest., Lond., Ser. 2, 1 (1).

Table 23. Landings of three size categories by Aberdeen trawlers from Faroe – 1957

Cwt. per 100 hours

Month	Hours fishing	Large	Medium	Small	Total
January ...	3,215	48.8	84.3	75.7	208.8
February ..	4,536	45.9	92.6	66.8	205.3
March	7,426	42.6	72.0	41.5	156.2
April	5,526	68.7	94.9	67.6	231.1
May	5,423	55.1	80.4	65.9	201.4
June	9,727	41.2	48.9	60.3	150.3
July	11,008	59.7	64.9	71.1	195.7
August	8,357	73.2	75.1	64.3	212.6
September .	6,411	56.7	53.6	64.4	174.6
October ...	5,751	30.0	37.5	41.1	108.6
November .	7,060	39.0	62.9	74.2	176.1
December .	7,557	37.1	77.3	74.8	189.2
Total/Mean	81,997	50.3	68.2	63.8	182.2

There was also the usual tendency for the mean lengths of each age-group to decrease from March to April.

The average weights of haddock, per 100 hours' fishing landed by Aberdeen trawlers from Faroe

Table 22. Aberdeen trawlers' market samples – Faroe haddock – 1957

A. Number landed/10 hours fishing

Brood	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1956 ...	—	—	—	—	—	—	—	3.90	1.34	0.50	21.22	—
1955 ...	30.46	150.30	10.71	4.87	149.90	302.70	171.34	871.03	595.90	427.70	611.76	723.12
1954 ...	474.22	848.00	381.04	361.67	674.40	475.12	348.71	323.80	358.58	225.34	306.40	384.83
1953 ...	720.28	471.21	397.27	924.47	454.51	276.26	422.87	284.05	229.75	141.75	271.84	239.12
1952 ...	52.44	53.09	109.94	143.74	81.34	55.82	75.31	35.63	39.66	8.63	24.47	24.12
1951 ...	13.42	14.00	31.21	47.87	49.05	15.52	20.96	19.96	18.03	8.10	20.32	6.56
1950 ...	10.52	16.50	14.07	16.58	17.56	17.69	28.27	9.56	12.10	7.76	3.14	3.53
1949 ...	7.62	6.07	12.49	10.68	16.84	4.93	16.31	7.38	5.88	3.94	1.53	3.18
1948 ...	5.71	2.00	6.41	5.26	7.84	2.82	7.83	3.47	2.43	1.42	1.09	2.33
1947 ...	1.32	1.35	1.16	3.06	5.46	1.60	6.11	1.23	1.44	1.04	0.22	1.01
1946 ...	2.28	0.62	0.92	0.64	—	0.70	0.43	2.08	—	0.48	0.20	—
1945 ...	0.36	0.50	0.58	0.74	0.91	—	—	—	—	—	—	0.15
1944 ...	—	0.44	—	0.59	—	—	—	—	—	—	—	—
Total ..	1318.63	1564.08	965.80	1520.17	1457.81	1153.16	1098.14	1562.09	1265.11	826.66	1262.19	1387.95

B. Mean lengths of each age-group sampled

1956 ...	—	—	—	—	—	—	—	30.00	29.00	32.00	33.10	—
1955 ...	33.64	33.80	34.50	34.50	35.01	35.56	36.82	36.99	37.02	37.63	37.99	39.11
1954 ...	38.74	39.37	39.49	39.61	39.93	40.73	42.55	44.03	43.53	44.03	45.81	45.80
1953 ...	47.32	47.65	46.82	46.17	47.58	47.64	49.42	50.75	51.29	49.99	51.04	51.00
1952 ...	51.71	55.29	54.26	52.22	54.23	54.34	55.50	57.18	60.53	55.50	57.99	58.02
1951 ...	60.32	59.90	57.91	56.27	60.26	62.25	62.91	64.40	65.58	60.92	64.42	63.44
1950 ...	63.27	61.43	62.87	62.27	64.47	65.57	66.71	65.01	70.06	67.15	68.36	67.08
1949 ...	68.35	65.35	67.54	66.90	66.93	68.65	68.10	72.58	69.60	69.12	70.33	67.77
1948 ...	71.08	69.80	68.82	67.44	68.60	69.62	68.94	69.75	70.66	73.44	70.33	70.44
1947 ...	69.67	70.17	71.25	75.88	73.58	73.38	71.50	74.50	74.00	74.00	73.50	71.88
1946 ...	71.50	72.00	71.00	71.00	—	70.50	71.00	74.25	—	81.00	73.00	—
1945 ...	77.00	70.00	73.50	78.00	77.50	—	—	—	—	—	—	77.00
1944 ...	—	75.75	—	73.00	—	—	—	—	—	—	—	—

C. Estimated weights[1]) landed per 10 hours' fishing (in cwt.)

1956 ...	—	—	—	—	—	—	—	0.02	0.01	0.00	0.13	—
1955 ...	0.19	0.91	0.07	0.03	1.02	2.23	1.42	7.41	5.06	3.86	5.68	7.22
1954 ...	4.56	8.13	3.59	3.51	6.90	5.36	4.53	4.71	5.00	3.34	5.11	6.35
1953 ...	12.62	8.40	6.02	14.18	7.77	4.97	8.57	6.41	5.35	3.10	6.29	5.53
1952 ...	1.26	1.47	2.67	3.20	2.06	1.51	2.21	1.17	1.53	0.26	0.84	0.84
1951 ...	0.52	0.50	0.88	1.33	1.77	0.61	0.90	0.92	0.86	0.33	0.94	0.29
1950 ...	0.47	0.65	0.55	0.63	0.75	0.82	1.34	0.46	0.69	0.40	0.17	0.18
1949 ...	0.39	0.27	0.57	0.52	0.72	0.28	0.87	0.46	0.32	0.22	0.09	0.17
1948 ...	0.34	0.11	0.33	0.27	0.39	0.17	0.45	0.20	0.14	0.09	0.07	0.14
1947 ...	0.08	0.07	0.07	0.20	0.32	0.10	0.36	0.08	0.09	0.07	0.01	0.06
1946 ...	0.15	0.04	0.05	0.04	—	0.04	0.03	0.13	—	0.03	0.01	—
1945 ...	0.02	0.03	0.03	0.05	0.09	—	—	—	—	—	—	0.01
1944 ...	—	0.03	—	0.04	—	—	—	—	—	—	—	—
Total ..	20.60	20.61	14.83	24.00	21.79	16.09	20.68	21.97	19.05	11.70	19.34	20.79
Actual landings per 10 hours by Aberdeen trawlers	21.13	20.54	15.62	23.11	20.14	15.03	19.57	21.26	17.46	10.86	17.61	18.92

[1]) Estimated using data from RUSSELL, 1914.

during 1957, are shown in Table 23. The mean catch per 100 hours' fishing (182.2 cwt.) compares favourably with that of 174.1 cwt. in 1956 and continues the upward trend that started at 124.8 cwt. in 1952.

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Table 24. Age composition of haddock caught by F.R.S. "Explorer" in 1956 per 10 hours' trawling

(The values in brackets give the catches per 10 hours' fishing in old "Explorer" units)

Northern Area									
Month	Jan./Mar.	April/June		July/Sept.		Oct./Dec.		All months	
Hrs. trawling	—	1 1/2		4		1 1/2		7	
Year-class								Weighted mean	
1955	—	2,427	(899)	3,168	(1,173)	4,267	(1,580)	3,244	(1,201)
1954	—	2,420	(896)	1,452	(538)	3,827	(1,417)	2,168	(803)
1953	—	2,693	(997)	880	(326)	2,227	(825)	1,557	(577)
1952	—	3,260	(1,207)	532	(197)	560	(207)	1,123	(416)
1951 and over	—	1,387	(514)	150	(56)	287	(106)	444	(164)

North Central									
Month	Jan./Mar.	April/June		July/Sept.		Oct./Dec.		All months	
Hrs. trawling	—	15 1/2		4		—		19 1/2	
Year-class								Weighted mean	
1955	—	4,333	(1,605)	1,355	(502)	—		3,722	(1,379)
1954	—	1,204	(446)	765	(283)	—		1,114	(413)
1953	—	333	(123)	592	(219)	—		386	(143)
1952	—	204	(76)	697	(258)	—		305	(113)
1951 and over	—	17	(6)	80	(30)	—		30	(11)

Central									
Month	Jan./Mar.	April/June		July/Sept.		Oct./Dec.		All months	
Hrs. trawling	—	4 1/2		4		—		8 1/2	
Year-class								Weighted mean	
1955	—	6,906	(2,558)	8,450	(3,130)	—		7,633	(2,827)
1954	—	1,138	(421)	1,110	(411)	—		1,125	(417)
1953	—	151	(56)	312	(116)	—		227	(84)
1952	—	106	(39)	232	(86)	—		166	(61)
1951 and over	—	33	(12)	22	(8)	—		28	(10)

North Sea Stock

Scottish Investigations

(Tables 24–30)

Early in 1956, the procedure for sampling the North Sea haddock stocks was changed. The old F.R.S. "Explorer" was replaced by a new vessel. To ensure comparability of results, a comparative fishing test was arranged between the vessels, the old "Explorer" using her usual 30′ otter trawl and the new "Explorer" using what is to become her standard gear, a 48′ trawl with 30 fathom sweeps. The new vessel was found to catch 2.7 times as many haddock per hour's fishing as the old vessel.

The new "Explorer" undertook her first trawling survey in April/May 1956. This and the following surveys were arranged so as to cover the same ground as that covered by the old vessel in her special cruises.

The age composition of the haddock sampled by "Explorer" in 1956 and 1957 is given in Tables 24 and 25. In both years, the 1955 year-class stands out as being an unusually good one. The relative strengths of the 0-group haddock in 1956 and 1957 are given in Tables 26 and 27, and it appears that the 1956 year-class was extremely poor, and the 1957 one only poor/moderate.

Size composition

The mean sizes of the haddock sampled in 1956 and 1957 are given in Tables 28 and 29. In both years, the smallest haddock, age for age, came from the northern area.

British statistics

In Table 30 are given the landings of haddock by British steam trawlers from different parts of the North Sea in 1957.

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Table 25. Age composition of haddock caught by F.R.S. "Explorer" in 1957 per 10 hours' trawling

(The values in brackets give the catches per 10 hours' fishing in old "Explorer" units)

	Northern Area											
Month	Jan./Mar.		April/June		July/Sept.		Oct./Dec.		All months	
Hrs. trawling	—		3		2		2		7	
									Weighted mean	
Year-class										
1956	—		720	(267)	140	(52)	275	(102)	427	(158)
1955	—		3,213	(1,190)	2,160	(800)	2,250	(833)	2,637	(977)
1954	—		980	(363)	1,375	(509)	1,345	(498)	1,197	(443)
1953	—		370	(137)	870	(322)	635	(235)	588	(218)
1952 and over	—		363	(134)	305	(113)	110	(41)	274	(101)

	North Central									
Month	Jan./Mar.		April/June		July/Sept.		Oct./Dec.		All months	
Hrs. trawling	3		5		$4^1/_2$		$4^1/_2$		17	
									Weighted mean	
Year-class										
1956	227	(84)	416	(154)	93	(34)	67	(25)	205	(76)
1955	7,337	(2,717)	4,342	(1,608)	3,669	(1,359)	3,589	(1,329)	4,493	(1,664)
1954	433	(160)	470	(174)	653	(242)	444	(164)	505	(187)
1953	110	(41)	348	(129)	362	(134)	151	(56)	258	(96)
1952 and over	150	(56)	340	(126)	144	(53)	93	(34)	189	(70)

	Central									
Month	Jan./Mar.		April/June		July/Sept.		Oct./Dec.		All months	
Hrs. trawling	3		4		$4^1/_2$		$3^1/_2$		15	
									Weighted mean	
Year-class										
1956	30	(11)	35	(13)	24	(9)	94	(35)	45	(17)
1955	15,710	(5,819)	5,250	(1,944)	4,607	(1,706)	4,431	(1,641)	6,958	(2,577)
1954	423	(157)	162	(60)	264	(98)	428	(159)	307	(114)
1953	133	(49)	45	(17)	142	(53)	234	(87)	136	(50)
1952 and over	297	(110)	50	(19)	142	(53)	77	(29)	133	(49)

Table 26. Distribution and density of the 1956 brood in "Explorer" catches

(The values in brackets give the catches per 10 hours' fishing in old "Explorer" unit)

	Number of fish	Number of hours	Per 10 hours	
Northern	40	$5^1/_2$	73	(27)
North Central	8	4	20	(7)
Central	4	4	10	(4)
Total	52	$13^1/_2$	39	(14)

Table 27. Distribution and density of the 1957 brood in "Explorer" catches

(The values in brackets give the catches per 10 hours' fishing in old "Explorer" unit)

	Number of fish	Number of hours	Per 10 hours	
Northern	164	4	410	(152)
North-Central	319	9	354	(131)
Central	255	8	319	(118)
Total	738	21	351	(130)

Table 30. Landings of haddock by British steam trawlers from the North Sea in 1957

Quarterly period	North of Lat. 57°30′N.			Lat. 55°N. to 57°30′N.			South of Lat. 55°00′N.			All Areas		
	Weight landed 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.
Jan.–March	991	511	194	100	213	47	34	708	5	1,125	1,432	79
April–June	829	390	213	224	416	54	35	445	8	1,088	1,251	87
July–Sept.	440	290	152	961	561	171	166	553	30	1,567	1,404	112
Oct.–Dec.	679	381	178	831	485	171	203	719	38	1,713	1,585	108

Table 28. Mean lengths (cm.) and standard errors of haddock of each age-group from the North Sea – 1956

			Northern			North Central			Central		
					Number			Number			Number
Year-class	Age	Month	Mean	S.E.	of fish	Mean	S.E.	of fish	Mean	S.E.	of fish
1956	0+	April–June		NIL			NIL			NIL	
		July–Sept.	11.9	0.266	29	9.9	0.351	8	9.5	0.866	4
		Oct.–Dec.	15.2	0.400	11	[1]			[1]		
1955	1+	April–June	16.7	0.077	364	18.6	0.024	6,716	16.7	0.026	3,108
		July–Sept.	21.0	0.045	1,267	20.8	0.073	542	22.2	0.033	3,380
		Oct.–Dec.	23.6	0.056	640	[1]			[1]		
1954	2+	April–June	27.2	0.0889	363	28.9	0.062	1,867	27.0	0.088	512
		July–Sept.	29.6	0.0686	581	30.5	0.152	306	31.1	0.104	444
		Oct.–Dec.	30.9	0.0787	574	[1]			[1]		
1953	3+	April–June	32.6	0.117	404	33.9	0.139	516	31.8	0.348	68
		July–Sept.	33.3	0.130	352	35.8	0.229	237	34.8	0.175	125
		Oct.–Dec.	35.2	0.117	334	[1]			[1]		
1952	4+	April–June	36.5	0.132	489	38.4	0.176	316	38.2	0.640	48
		July–Sept.	35.8	0.172	213	40.7	0.249	279	37.8	0.289	93
		Oct.–Dec.	39.7	0.302	84	[1]			[1]		
1951	5+	April–June	39.7	0.310	208	43.9	1.059	27	44.3	1.067	15
		July–Sept.	41.4	0.773	60	44.6	0.475	32	39.9	1.020	9
		Oct.–Dec.	42.8	0.966	43	[1]			[1]		

[1]) Not visited.

Table 29. Mean lengths (cm.) and standard errors of haddock of each age-group from the North Sea – 1957

			Northern			North Central			Central		
					Number			Number			Number
Year-class	Age	Month	Mean	S.E.	of fish	Mean	S.E.	of fish	Mean	S.E.	of fish
1957	0+	July–Sept.	12.6	0.120	116	9.5	0.144	75	10.3	0.117	113
		Oct.–Dec.	15.2	0.274	48	15.8	0.133	244	16.4	0.181	142
1956	1+	Jan.–Mar.	—	—	[1]	17.5	0.202	68	18.4	1.107	9
		April–June	20.5	0.095	216	19.8	0.087	208	20.1	0.339	14
		July–Sept.	23.5	0.209	28	24.5	0.301	42	24.5	0.281	11
		Oct.–Dec.	24.8	0.147	55	25.0	0.273	30	25.9	0.461	33
1955	2+	Jan.–Mar.	—	—	[1]	26.5	0.041	2,201	26.0	0.026	4,713
		April–June	25.4	0.062	964	25.5	0.042	2,171	26.9	0.049	2,100
		July–Sept.	27.6	0.102	432	28.9	0.067	1,651	29.6	0.059	2,073
		Oct.–Dec.	28.7	0.096	450	30.0	0.069	1,615	31.2	0.060	1,551
1954	3+	Jan.–Mar.	—	—	[1]	32.2	0.292	130	32.5	0.188	127
		April–June	32.5	0.147	294	33.9	0.218	235	34.9	0.325	65
		July–Sept.	34.4	0.129	275	35.8	0.183	294	37.3	0.260	119
		Oct.–Dec.	34.0	0.162	269	36.5	0.293	200	35.0	0.239	150
1953	4+	Jan.–Mar.	—	—	[1]	38.0	0.712	33	36.4	0.326	40
		April–June	37.1	0.305	111	38.1	0.304	174	38.9	0.788	18
		July–Sept.	37.7	0.223	174	39.7	0.232	163	40.2	0.453	64
		Oct.–Dec.	38.5	0.260	127	41.2	0.480	68	40.1	0.347	82
1952	5+	Jan.–Mar.	—	—	[1]	42.3	0.831	44	41.2	0.551	82
		April–June	39.8	0.386	79	40.5	0.355	133	43.2	1.128	18
		July–Sept.	42.5	0.666	53	44.3	0.529	64	42.4	0.300	52
		Oct.–Dec.	41.3	0.600	18	46.6	0.826	34	43.3	0.725	22

[1]) Not visited.

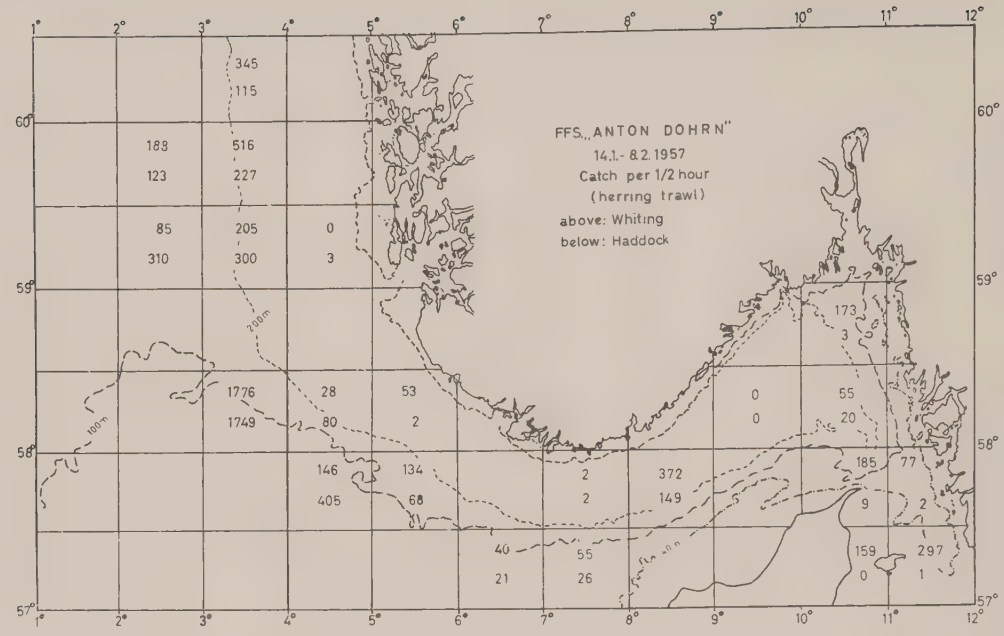

Figure 20. Mean catch of haddock and whiting per half-hour trawling of the F.R.S. "Anton Dohrn" in the Skagerak and the north-eastern North Sea in January/February 1957 (herring trawl).
Above = whiting.
Below = haddock.

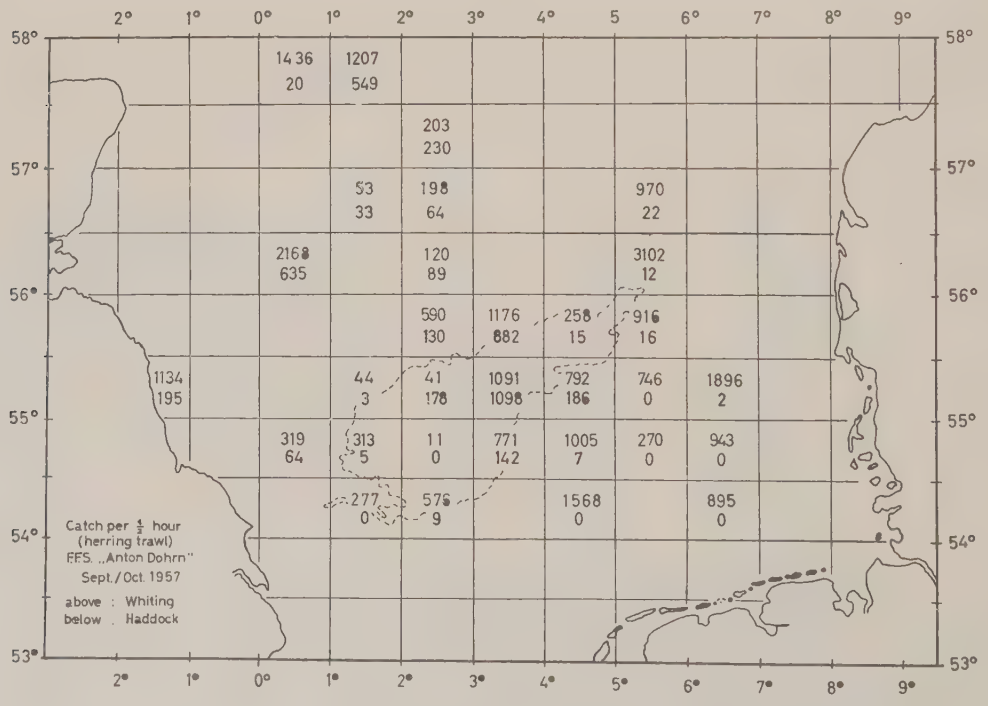

Figure 21. Mean catch of haddock and whiting per half-hour trawling of the F.R.S. "Anton Dohrn" in the North Sea in September/October 1957 (herring trawl).
Above = whiting.
Below = haddock.

Table 31. Mean catch per 10 hours' trawling (number of fish) and age composition (%) of haddock caught by the F.R.S. "Anton Dohrn" in the North Sea and Skagerak in January/February 1957
(Herring trawl)

Age-group	Year-class	Viking Bank/ Utsira	Ling Bank 100–220 m. depth	Ling Bank < 100 m. depth	Skagerak
0	1956	790 (22)	131 (12)	225 (3)	73 (17)
I	1955	1,670 (48)	778 (71)	4,780 (56)	270 (64)
II	1954	534 (15)	98 (9)	1,420 (17)	64 (15)
III	1953	304 (9)	53 (5)	1,115 (13)	12 (3)
IV	1952	172 (5)	31 (3)	775 (9)	5 (1)
V	1951	30 (1)	4 (+)	145 (2)	— —
VI	1950	2 (+)	— —	— —	— —
VII	1949	— —	— —	5 (+)	— —
All ages		3,502 (100)	1,095 (100)	8,465 (100)	424 (100)
Trawl stations		10	9	4	27

Table 32. Mean lengths (cm.) [1]) of haddock caught by the F.R.S. "Anton Dohrn" in the north-eastern North Sea and Skagerak in January/February 1957
(Herring trawl)

Age-group	Year-class	Viking Bank/Utsira Mean	Range	No. of fish	Ling Bank 100–220 m. depth Mean	Range	No. of fish	Ling Bank < 100 m. depth Mean	Range	No. of fish	Skagerak Mean	Range	No. of fish
0	1956	18.0	13—22	395	17.6	12—20	59	17.1	13—19	45	20.4	14—24	99
I	1955	25.9	20—33	83	25.4	20—33	60	26.7	20—35	424	29.5	20—36	292
II	1954	33.0	26—40	168	35.3	28—42	10	34.2	25—45	197	36.6	23—49	67
III	1953	38.8	30—47	112	44.3	38—56	12	40.6	31—51	170	48.6	38—58	14
IV	1952	43.0	36—53	55	50.4	45—63	9	45.2	36—55	113	(53.2)	45—62	5
V	1951	47.8	41—60	7	(64.5)	64	2	51.0	44—65	15	—	—	—
VI	1950	(62.5)	62	1	—	—	—	—	—	—	—	—	—
VII	1949	—	—	—	—	—	—	(73.0)	73	1	—	—	—

[1]) Fish measurements were made to the "centimetre below". The data of mean lengths given previously in Ann. Biol., **12**, Table 27, p. 151 and **13**, Tables 25—26, pp. 153 and 155 are to be raised by 0.5 cm. which erroneously has been omitted.

Table 34. Mean lengths (cm.)[1]) of haddock caught by the F.R.S. "Anton Dohrn" in the North Sea in September/October 1957
(Herring trawl)

Age-group	Year-class	Fladen Ground Mean	Range	No. of fish	Dogger Bank/Gut Mean	Range	No. of fish	German Bight Mean	Range	No. of fish
0	1957	12.5	8—16	98	12.9	11—15	11	14.7	11—16	21
I	1956	26.1	21—29	82	26.7	20—29	130	27.5	25—29	8
II	1955	31.0	25—39	76	33.2	26—45	242	34.9	27—45	126
III	1954	35.1	30—48	29	39.9	32—52	66	39.7	32—52	12
IV	1953	43.8	39—56	12	46.6	41—54	19	(54.2)	51—55	4
V	1952	—	—	—	(48.0)	44—51	2	(55.0)	51—58	2

[1]) See footnote to Table 32.

German Investigations

(Figures 20–21; Tables 31–34)

Data as to the composition and distribution of the haddock population of the North Sea were collected during three cruises of the F. R. S. "Anton Dohrn". In January—February research was made in the Skagerak and the areas of the north-eastern North Sea, whereas in September—October the areas German Bight, Dogger Bank, Gut, and Fladen Ground were visited. As in previous years sampling was carried out by the ordinary herring trawl. All hauls were of half an hour's duration.

Table 33. Mean catch per 10 hours' trawling (number of fish) and age composition (%) of haddock caught by the F.R.S. "Anton Dohrn" in the North Sea in September/October 1957
(Herring trawl)

Age-group	Year-class	Fladen Ground	Dogger Bank/ Gut	German Bight
0	1957	490 (11)	9 (+)	25 (5)
I	1956	410 (9)	108 (4)	9 (2)
II	1955	3,125 (69)	2,640 (86)	467 (84)
III	1954	405 (9)	262 (9)	45 (8)
IV	1953	85 (2)	47 (1)	5 (1)
V	1952	— —	7 (+)	2 (+)
All ages		4,515 (100)	3,073 (100)	553 (100)
Trawl stations		4	24	17

The mean catch per unit effort and the percentage age composition of haddock in the different areas are given in Tables 31 and 33. As in the year before the catches consisted mainly of haddock of the strongly predominant 1955 year-class. Besides, only the 1954 year-class was of some importance. The 1956 brood was poorly represented in the catches, and haddock born in 1957 were also caught in small numbers only. The 1957 year-class seems to be poor.

A review of the average catch per unit effort of haddock and whiting by rectangles, worked up after experimental trawling data, is given in Figures 20 and 21.

Tables 32 and 34 show the mean lengths of haddock of the different year-classes in the areas visited.

D. Sahrhage

SAITHE

Iceland and Arcto–Norwegian Stocks

German Investigations on Commercial Saithe Landings in 1957

(Figures 22–24; Tables 35–37)

Tables 35 and 36 show the main features of the length frequency distribution, age composition, and growth of the different age-groups from German commercial landings of saithe from Icelandic and Norwegian waters in 1957; the data for the mean catch per day's fishing and the total annual yield are also shown. The figures are based on age determinations of 19,837 saithe caught by German trawlers in Icelandic waters during the period January to December 1957, and on age determinations of 14,437 saithe caught off the Norwegian coast during the same period.

For comparison, a general view of the length and age distribution of German saithe catches since 1946/47 is given in Figures 22—24 for the different fishing seasons. Concerning Icelandic waters the latter are from April to March. Figure 22 shows the length distribution of German landings from all Icelandic fishing grounds summarized in 5 cm. groups (on the left). Graphs giving the deviation from the mean size frequencies are shown in the middle, and the age composition for the corresponding years is illustrated on the right. Figures 23 and 24 deal with the length frequencies and age composition of the landings from Norwegian waters and are shown separately.

The market landings of saithe from Icelandic and Norwegian waters in 1957 are more or less on the same level as in 1956 (see Tables 35 c and 36 c). In Icelandic waters about half of the total annual catch was obtained during the summer from the north-western area which, in recent years, has become a centre for saithe fishing. Rough weather and bad conditions for the fishery prevented us from obtaining better catches from this area. In general, there was a distinct predominance of the 1949—51 year-classes in all Icelandic areas, with a length range of 65—85 cm. The 1950 year-class is by far the most numerous. The occurrence of large, old fish, especially those of the 1944—46, 1939, and 1937 year-classes, is without exception, insignificant. But the recruitment from the 1952—54 year-classes is also relatively weak; for that reason the outlook for the fishery in Icelandic waters is not favourable, especially the lack of recruits to replace the 1950 and 1951 year-classes.

In Norwegian waters the 1950 year-class is predominant on the spawning grounds of the Svinøy area (see Table 36), and the 1951 and 1952 year-classes are present in fairly large numbers. However, according to the initial strength of the 1950 year-class these fish should have occurred in much greater abundance on the spawning grounds because, generally, the best yield of a really rich year-class is obtained when the fish is seven years old. Nevertheless, the low level of the yield of the fishery at Svinøy in 1956/57 and 1957/58 is chiefly a result of commercial restrictions. It is to be noted that the recruit 1952 year-class in the season 1957/58 provided a great proportion of the catches, though these fish were only partly mature.

On the Lofoten banks the young fish of the 1952 year-class predominated by far. About half of all trawler-caught fish on the Lofoten banks belong to this year-class. Together with the 1950 and 1951 year-classes it forms a population density almost as high as in 1956; it should, however, be noted that the proportion of the stock formed by these year-classes is much smaller than might have been expected from the age composition of former years.

When comparing the results obtained in 1957 with those of previous fishing seasons, it is very striking how much fluctuations in year-class strength influence the yield of the fishery and the catch per unit effort, both in Icelandic and Norwegian waters. This is clearly seen from the age and length distributions, shown in Figures 22—24,

Table 35

(a) Length and age composition of the German landings of saithe in 1957 from Icelandic waters (‰)

cm.	Length frequencies: North-west coast	South and south-west coast	South-east coast	All areas	Age composition: Year-class	North-west coast	South and south-west coast	South-east coast	All areas	Mean length of age-groups in cm.: North-west coast	South and south-west coast	South-east coast	All areas
36— 40	1	—	+	+	1954	4	—	—	2	45.5	—	—	45.5
41— 45	3	—	+	1	1953	39	11	4	24	53.9	57.4	52.1	54.5
46— 50	7	+	2	4	1952	78	26	52	58	63.4	63.7	63.0	63.4
51— 55	19	9	16	16	1951	277	174	208	244	70.9	70.7	70.0	70.5
56— 60	26	48	25	38	1950	365	353	455	371	77.5	77.0	74.6	76.4
61— 65	79	93	63	91	1949	118	175	181	142	85.5	84.8	82.5	84.3
66— 70	155	118	182	149	1948	41	61	54	48	93.2	91.8	90.3	91.8
71— 75	228	176	259	212	1947	11	13	11	11	97.7	95.9	94.3	96.0
76— 80	213	126	204	178	1946	9	20	10	13	100.6	98.8	96.5	98.6
81— 85	102	103	117	102	1945	10	19	8	13	102.9	101.8	99.1	101.3
86— 90	50	79	62	60	1944	9	17	6	11	104.6	103.5	101.4	103.2
91— 95	35	56	33	40	1943	4	10	3	6	106.4	105.1	103.8	105.1
96—100	24	37	19	27	1942	3	7	1	4	107.4	106.0	104.6	106.0
101—105	22	35	11	24	1941	6	14	2	8	107.9	108.7	105.4	107.3
106—110	25	52	5	30	1940	5	9	+	5	108.8	110.0	106.5	108.4
111—115	10	49	2	21	1939	14	38	3	20	110.5	110.6	110.4	110.5
116—120	1	18	+	7	1938	2	9	+	4	111.0	112.3	111.1	111.5
121—125	+	1	—	+	1937	3	26	1	10	112.1	113.3	114.8	112.6
Total number of fish	2,820,652	1,992,359	751,527	5,564,438	1936	1	7	+	2	—	114.3	—	113.0
					1935	1	9	+	3	—	115.2	—	115.2
Kilogrammes	10,129,888	7,764,047	2,529,639	20,423,574	1934	+	1	—	+	—	—	—	—
					1933	+	1	—	+	—	—	—	—

(b) Mean catch per day's fishing (all Icelandic fishing areas)

Fishing season May to April	1946/47	1947/48	1948/49	1949/50	1950/51	1951/52	1952/53	1953/54	1954/55	1955/56	1956/57	1957/58[1])
Number of fish	1,728	1,437	1,050	748	914	785	629	485	702	730	932	917
Kilogrammes	7,290	5,230	4,425	3,200	3,750	3,917	2,975	2,100	2,358	2,417	3,023	3,367

[1]) Preliminary figures (May to February).

(c) Commercial landings of saithe from Icelandic waters by German trawlers (in tons)

	1950	1951	1952	1953	1954	1955	1956	1957[1])
Size category I (large)	22,825	24,860	22,632	16,019	12,586	7,362	7,850	6,424
Size category II + III (medium and small)	7,010	8,759	12,692	7,422	11,834	8,982	13,786	14,000
Total	29,835	33,439	35,324	23,441	24,420	16,344	21,636	20,424

[1]) Preliminary figures.

by comparison of the three columns. Within the last twelve fishing seasons, three waves of recruitment to the stock have occurred in Icelandic waters, which have been sufficient to influence the stock, viz., the first, consisting of the 1935—40 year-classes of which the 1937 and 1939 classes were the strongest; the second, the 1944—46 year-classes; and the third, the 1949—51 year-classes which again caused an increase in the mean catch per day's fishing. In Norwegian waters the 1943 and 1944 year-classes have been very important to the fishery, and after a period of poor broods, several successive waves of recruits have appeared, namely the 1949—1952 year-classes which are present on the Lofoten banks as well as in the Svinøy area. Generally, a distinct predominance of young year-classes is noted during the last few fishing seasons, both in Icelandic and Norwegian waters, and we may conclude that even rich year-classes exist at present only for a relatively short time before they are outfished.

The influence of variations in year-class strength on the yield of the fishery is thus evident. A more detailed study, however, indicates that in addition to the normal fluctuations in year-class strength some other factors must affect the yield (see Ann. Biol., 13: 156—60, 164—65; Ber. Dtsch. Wiss. Komm. Meeresf., 14: 145—58). These are (1)

Table 36

(a) Length and age composition of the German landings of saithe from Norwegian waters in 1956/57 and 1957/58 (‰)

Lofoten Banks

cm.	Length frequencies 1956/57	Length frequencies 1957/58[1])	Year-class	Age composition 1956/57	Age composition 1957/58[1])	Mean length of age-groups 1956/57	Mean length of age-groups 1957/58[1])
36– 40	+	—	1954	—	+	—	46.1
41– 45	+	+	1953	2	70	49.6	54.7
46– 50	12	9	1952	271	477	55.5	62.9
51– 55	109	82	1951	273	242	62.3	69.2
56– 60	212	170	1950	305	124	69.0	76.4
61– 65	222	262	1949	81	40	76.6	82.5
66– 70	195	200	1948	17	12	82.6	87.3
71– 75	127	112	1947	11	8	87.9	90.9
76– 80	52	75	1946	10	7	90.4	93.3
81– 85	21	40	1945	5	4	92.5	95.5
86– 90	18	19	1944	7	4	94.3	97.3
91– 95	15	13	1943	5	4	96.6	99.9
96–100	10	10	1942	3	2	98.9	101.8
101–105	5	5	1941	3	2	100.1	103.0
106–110	2	2	1940	2	1	101.7	104.7
111–115	+	+	1939	2	1	103.5	105.7
116–120	+	+	1938	1	1	105.7	106.5
Total number of fish	5,271,104	5,691,847	1937 and older	1	+	—	—
kg.	12,007,661	13,105,616					

Spawning stock at Svinøy

cm.	Length frequencies 1956/57	Length frequencies 1957/58[2])	Year-class	Age composition 1956/57	Age composition 1957/58[2])	Mean length of age-groups 1956/57	Mean length of age-groups 1957/58[2])
36– 40	—	—	1954	—	+	—	49.5
41– 45	—	—	1953	—	82	—	57.5
46– 50	+	6	1952	22	213	57.6	65.1
51– 55	7	42	1951	268	307	65.0	72.2
56– 60	49	64	1950	353	230	72.7	78.7
61– 65	137	99	1949	181	96	80.0	84.3
66– 70	193	183	1948	42	25	85.4	89.1
71– 75	217	210	1947	29	13	89.1	91.8
76– 80	151	174	1946	32	9	91.9	94.2
81– 85	97	120	1945	13	6	93.7	96.7
86– 90	48	53	1944	13	6	96.4	99.0
91– 95	46	22	1943	10	5	98.5	100.7
96–100	28	14	1942	7	2	100.4	103.4
101–105	17	9	1941	11	2	101.9	105.6
106–110	7	3	1940	5	2	103.5	106.0
111–115	3	1	1939	6	2	104.6	107.4
116–120	+	—	1938	1	+	—	—
Total number of fish	1,169,422	1,176,119	1937 and older	7	+	—	—
kg.	3,582,188	3,408,911					

(b) Mean catch per day's fishing

Fishing season	1950/51		1951/52		1952/1953		1953/54		1954/55		1955/56		1956/57		1957/58	
	Number of fish	kg.	Number of fish	kg.	Number of fish	kg.	Number of fish	kg.	Number of fish	kg.	Number of fish	kg.	Number of fish	kg.	Number of fish	kg.
Lofoten banks	1,923	6,043	1,056	3,031	2,067	6,047	1,696	5,007	2,147	5,837	2,627	7,096	3,079	7,370	2,952	6,978[1])
Svinøy area	5,413	19,244	8,516	27,609	5,279	19,470	2,734	10,249	4,007	14,774	3,874	12,673	7,593	21,619	5,421	14,828[2])

(c) Commercial landings of saithe by German trawlers from the Norwegian coast (in tons)

Fishing season (April to March)	1950/51	1951/52	1952/53	1953/54	1954/55	1955/56	1956/57	1957/58
Lofoten banks	20,677	9,659	16,359	7,430	13,288	14,376	12,008	13,106[1])
Svinøy area	8,646	12,513	3,837	7,487	7,848	5,467	3,582	3,409[2])
Total	29,323	22,172	20,196	14,917	21,136	19,843	15,590	16,515

[1]) Preliminary figures (April to February).

[2]) Preliminary figures (December to February).

environmental factors, temporarily influencing the yield of the fishery; (2) changes in migration habits, such as the disappearance from Icelandic waters after the onset of maturity of the initially strong 1945 year-class, and (3) the behaviour in Norwegian waters of the 1944 year-class which failed to appear in the Lofoten catches, thus resulting in a complete break-down of the German commercial trawling, whereas the same year-class was abundantly represented among the spawning stock at Svinøy. These facts should not be discussed at length in this place, attention should only be drawn to the most important irregularities in the behaviour of the stock of saithe, because, as long as the interrelationship between stock density, environmental factors, and migrations are unknown it is most difficult to obtain reliable data for an estimation of population parameters and for a correct forecast of the future yield.

In 1957, the behaviour of the stock of saithe was very irregular, especially as regards migration habits. These irregularities were as follows:—

1. The appearance, in the vicinity of the Faroes, in December 1956 and January 1957, of unusually large quantities of old saithe coinciding with the disappearance of large, old saithe from the south-western Icelandic spawning grounds. Certain features of growth-rate and otolith structure would suggest that a temporary immigration from Icelandic to Faroese waters had taken place. These immigrants had left the Faroe area by February 1957 and they returned in small numbers only, as

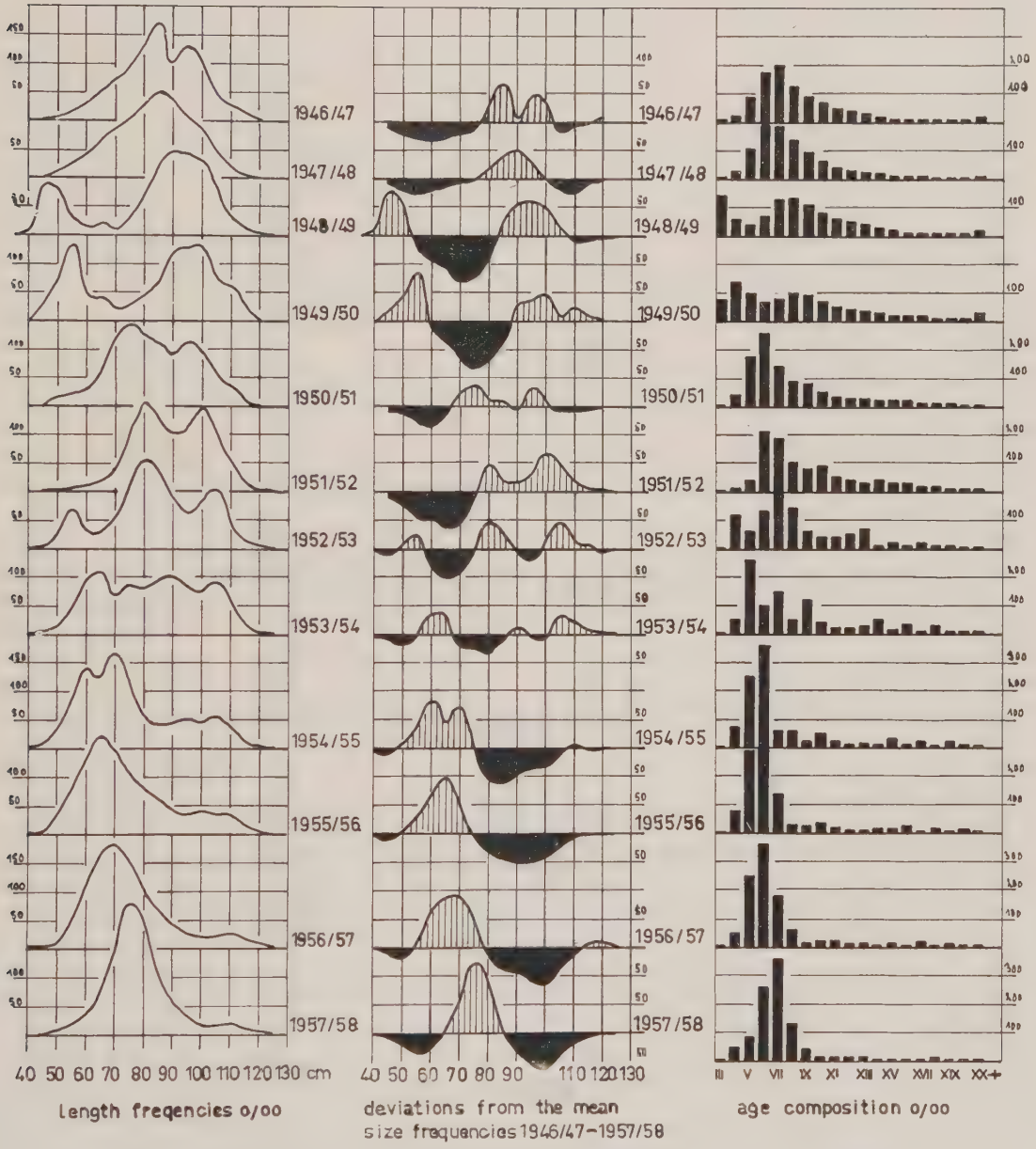

Figure 22. Length and age distribution of the German landings of saithe from Icelandic waters in the period 1946/47–1957/58.

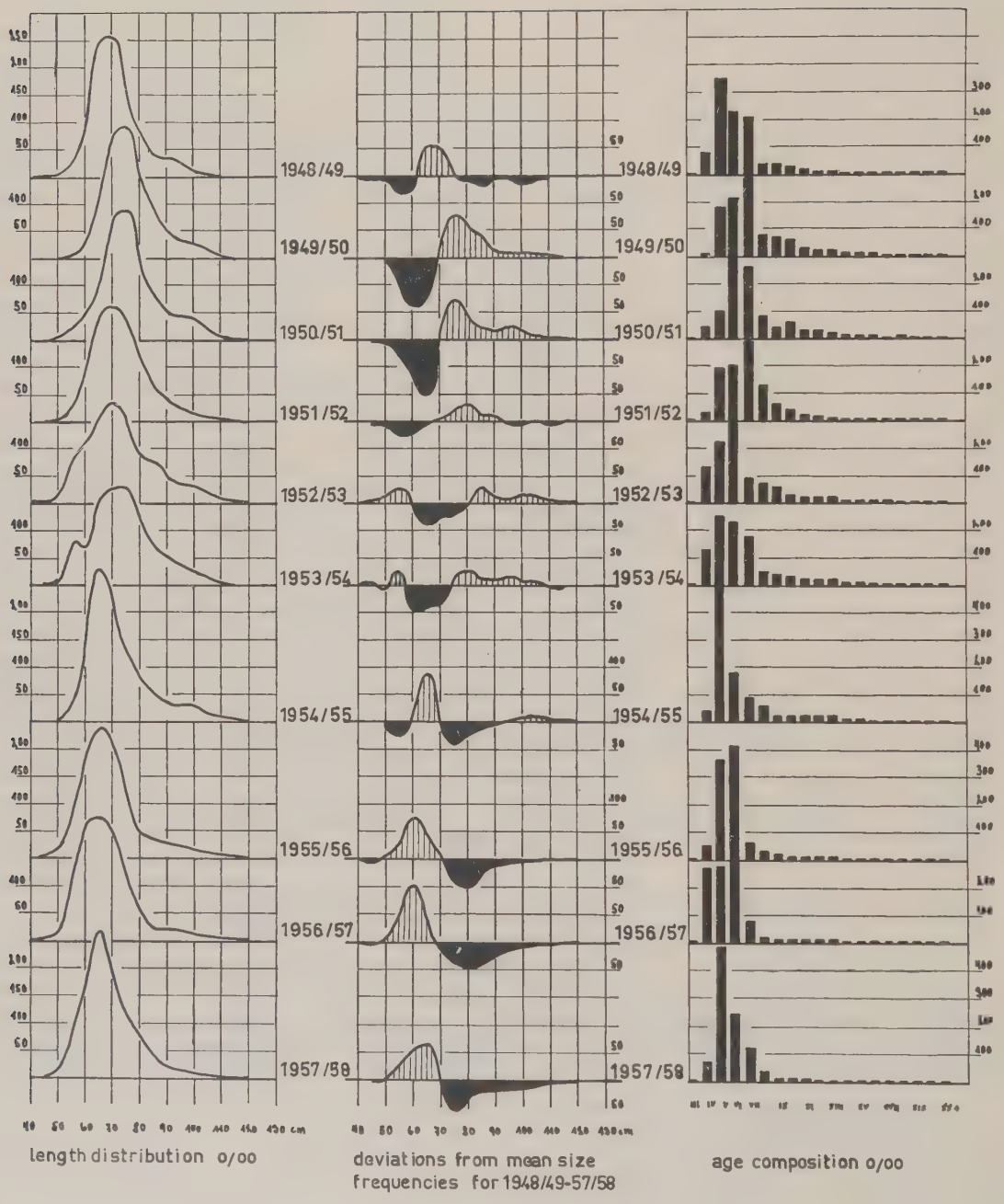

Figure 23. Length frequencies and age distribution of German saithe landings off the Lofoten banks in the period 1948/49–1957/58.

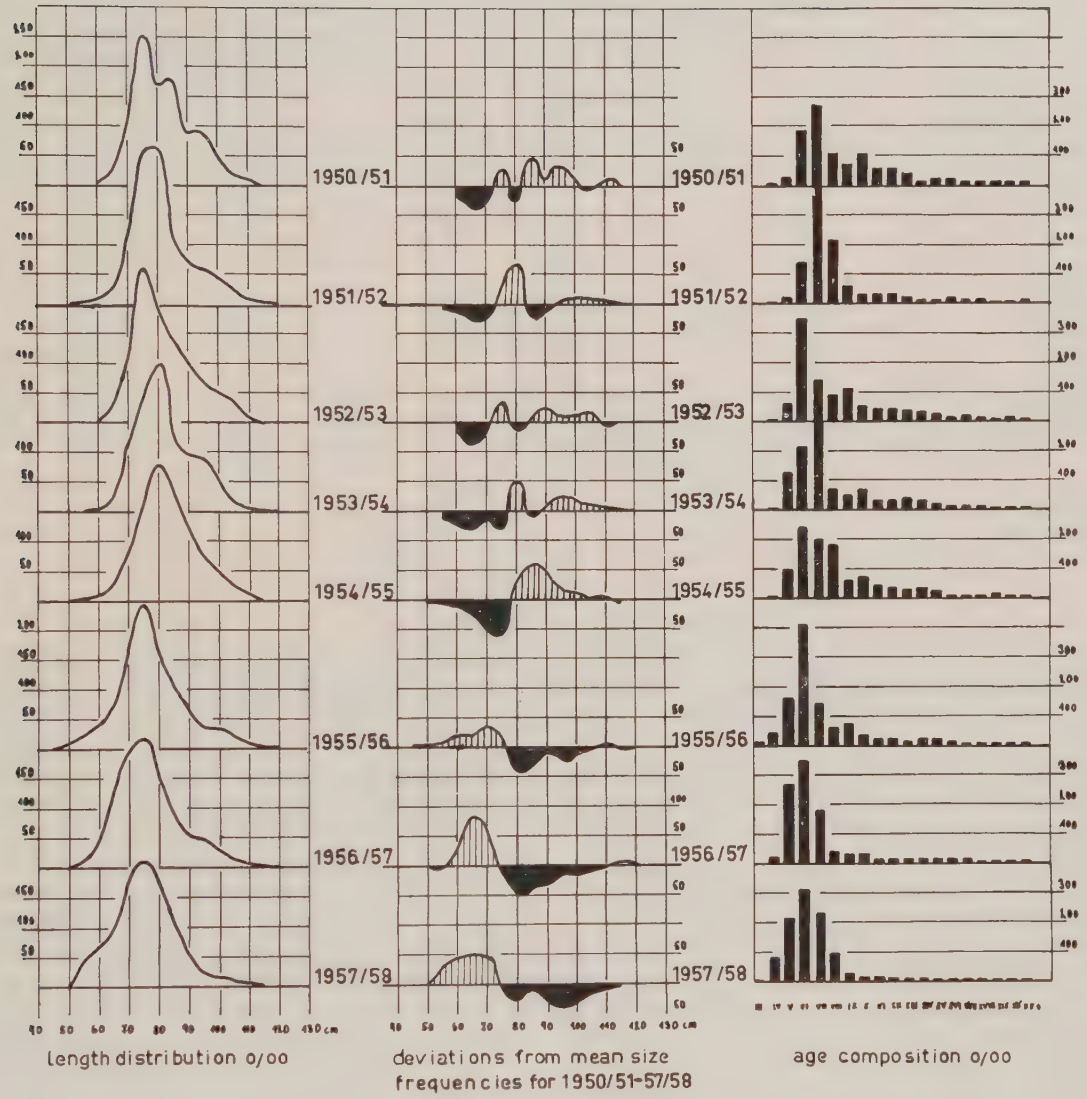

Figure 24. Length frequencies and age composition of German saithe landings from Svinøy in the period 1950/51–1957/58.

proved by the catches in the following fishing season, which started in September 1957 and lasted until February 1958. The main characteristics of the German catches in Faroese waters are given in Table 37. The predominating year-classes are those of 1949 and 1950. The old 1939, 1945, and 1947 year-classes are present only in relatively small numbers, thus demonstrating that the bulk of the Icelandic immigrants have left this region. But another remarkable factor is observed: the growth-rate of the 1949—51 year-classes is considerably lowered. This might possibly be an effect of another immigration into Faroese waters.

2. Saithe of Norwegian origin tagged in 1955 and 1956 off the Norwegian north coast appeared in the period from January to March 1957 in the German catches from the northern North Sea and Faroe. In January and April 1958 saithe tagged off the Norwegian north coast were again recovered in the northern North Sea and at the Faroes. Due to the

Table 37. Length and age composition of the German landings from Faroe waters (‰)

Fishing season	Length frequencies 1956/57	1957/58[1])
cm.		
51— 55	—	+
56— 60	—	1
61— 65	2	3
66— 70	3	19
71— 75	11	68
76— 80	33	123
81— 85	74	154
86— 90	107	114
91— 95	138	120
96—100	192	179
101—105	219	146
106—110	157	56
111—115	55	16
116—120	8	1
121—125	1	+
Number of fish	1,075,249	1,786,533
Kilogrammes	7,361,881	10,213,516
Mean catch per day's fishing		
Number of fish	1,352	1,319
Kilogrammes	9,223	7,610

Year-class	Age composition 1956/57	1957/58[1])	Mean length of age-groups, cm. 1956/57	1957/58
1953	—	1	—	60.0
1952	—	14	—	70.8
1951	7	80	70.7	75.6
1950	31	189	78.4	80.7
1949	105	178	84.0	86.7
1948	74	71	89.2	92.3
1947	75	64	92.4	95.1
1946	92	63	95.4	97.8
1945	104	74	98.4	99.9
1944	69	79	100.7	101.8
1943	60	42	102.1	103.0
1942	61	38	103.3	104.4
1941	94	37	104.9	105.1
1940	41	22	106.2	105.9
1939	103	37	107.6	107.8
1938	22	6	109.1	108.6
1937	47	4	110.1	—
1936	8	—	—	—
1935 and older	7	1	—	—

[1]) Preliminary figures.

lower growth-rate of the Norwegian stock it cannot be denied that the decline in the growth-rate of the 1949—51 year-classes in Faroese waters, as observed in the German catches in 1957, results from an immigration of saithe of Norwegian origin, and thus a mixture of fish of Faroese, Norwegian, and Icelandic origin occurs in Faroese waters in 1957/58.

3. In May/June 1957 saithe of Norwegian origin reached the south-eastern Icelandic waters and, in July/September 1957, the north-west coast of Iceland. These fish belonged to the 1949—51 year-classes according to their length range of 65—85 cm. At the same time a decrease in the average length of the corresponding age-groups, especially in north-western Icelandic waters, was observed which is supposed to have been produced by an extended immigration of saithe of Norwegian origin into the Icelandic area. A mixing of different stocks which up to now were considered independent seems to have taken place, and the more as further into June 1958 it was possible to catch saithe of Norwegian origin off the south-eastern coast of Iceland.

4. These long-distance migrations disagree completely with the results of the Norwegian tagging experiments, so far as the latter had proved the existence of a "homing instinct" in the Norwegian saithe. Whatever may have been the cause of these migrations is at present a puzzle. It might be that they are correlated with the extremely low bottom temperatures in the southern Barents Sea, as shown by Soviet investigations. This area is one of the most important feeding grounds for the young fish and therefore the unusually far-reaching southward migration of the recruits, extending from off the Norwegian coast to the Svinøy area, is interesting and remarkable. And it is probably more than a coincidence that especially the 1949—51 year-classes, which mainly immigrated into Icelandic waters, are found in smaller numbers on the Norwegian spawning grounds than might be expected in view of the more than normal strength of these three year-classes.

5. Concerning the influence of environmental factors on the behaviour of fish and their availability to the fishery, attention has been drawn to the important relations between density of the stock and hydrographical and meteorological conditions. According to the results from a cruise with "Anton Dohrn" in 1956 internal waves, which probably are related to changes in barometric pressure, influence the local distribution of saithe, but of the effect on the fish itself we have only the faintest conception. Further studies on this important correlation were made in November 1957. The results of continuous temperature measurements over a period of 36 hours indicate that temporary changes in different water layers occur which are possibly related to internal waves; but, on the other hand, strong and temporarily variable surface currents amounting to 3 miles/hr. have been observed on the edges of the fishing grounds.

They are probably released by tidal currents covering the effect of the internal waves. When variations occur in the daily yield on the same fishing ground, a fact which has often been observed, it seems to be the result of an interaction of several forces, such as the winds, producing the surface currents, tidal currents, the shape of the slope of the fishing ground, and changes in the barometric pressure influencing the internal waves. Investigations of this very complex problem cannot be carried out by a single ship, but require at least two or three ships working simultaneously on fishery and hydrographical investigations. In order to elucidate the dynamics of the saithe populations and their migrations this problem must be solved.

ULRICH SCHMIDT

WHITING

North Sea Stock

British Statistics

(Table 38)

The data in Table 38 are presented as a summary of landings by British steam trawlers in 1957. The summary for 1954—1956 will be found in Ann. Biol., 13, p. 166.

R. JONES, R. GAMBLE

Table 38. Landings of whiting by British steam trawlers from the North Sea in 1957

Quarterly Period	North of Lat. 57°30′N.			Lat. 55°N. to 57°30′N.			South of Lat. 55°00′N.			All Areas		
	Weight landed 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed 100 cwt.	100 hrs. fishing	Weight landed 100 hrs
Jan.—March .	444	511	87	77	213	36	26	708	4	547	1,432	38
April—June .	206	390	53	62	416	15	9	445	2	277	1,251	22
July—Sept. ..	126	290	43	199	561	35	30	553	5	355	1,404	25
Oct.—Dec. ...	312	381	82	222	485	46	28	719	4	562	1,585	35

German Investigations

(Figures 25–27; Tables 39–42)

Sampling of the whiting stock of the North Sea was carried out during two cruises with the F.R.S. "Anton Dohrn". Experimental trawling with the ordinary herring trawl was made in January/February in the areas Skagerak, Ling Bank, Utsira, and Viking Bank; in September/October the areas German Bight, Dogger Bank, Gut, and Fladen Ground were visited. All hauls were of half an hour's duration.

The mean numbers of whiting of the different year-classes caught per half-hour trawling and the corresponding percentage age composition are shown in Tables 39 and 41. In most areas the very numerous 1955 year-class predominated. In the eastern North Sea, however, a difference by depth may be stated (Table 39 and Figure 25). The young fish were mainly present in shallower waters (Skagerak and Ling Bank, down to 100 m. depth), whereas the older age-groups occurred in deeper waters (Ling Bank at 100—220 m. depth and

Table 39. Mean catch per half-hour trawling (number of fish) and age composition (%) of whiting caught by the F.R.S. "Anton Dohrn" in the North Sea and Skagerak in January/February 1957

(Herring trawl)

Age-group	Year-class	Viking Bank/ Utsira		Ling Bank 100–220 m. depth		Ling Bank < 100 m. depth		Skagerak	
0	1956	—	—	1	(1)	7	(2)	65	(51)
I	1955	38	(11)	20	(24)	318	(80)	51	(40)
II	1954	106	(30)	25	(30)	62	(16)	9	(7)
III	1953	124	(36)	27	(32)	7	(2)	2	(2)
IV	1952	62	(18)	9	(11)	—	—	1	(+)
V+	1951+	17	(5)	2	(2)	—	—	—	—
All ages		347	(100)	84	(100)	394	(100)	128	(100)
Trawl stations		8		7		6		18	

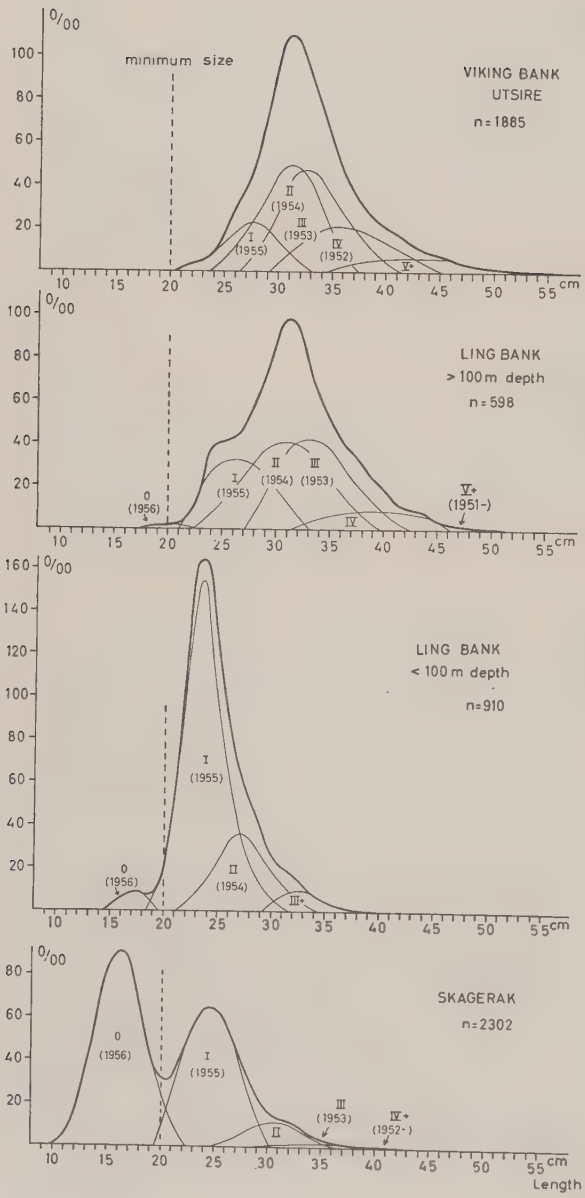

Figure 25. Percentage length distribution and age composition of whiting caught in January/February 1957 by the F.R.S. "Anton Dohrn" in the Skagerak and north-eastern North Sea (herring trawl).

Utsira/Viking Bank). A considerable number of 0-group whiting (1956 year-class) was only present in the Skagerak area. Also the 1957 brood was proportionately poorly represented in the catches taken in the North Sea in September/October, as shown in Table 41 and Figure 26.

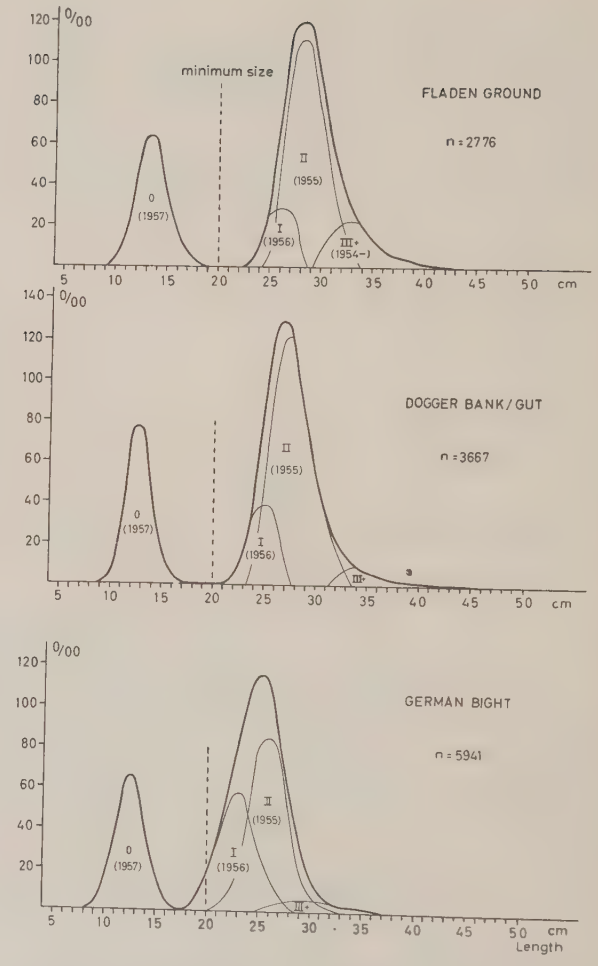

Figure 26. Percentage length distribution and age composition of whiting caught in September/October 1957 by the F.R.S. "Anton Dohrn" in the North Sea (herring trawl).

Table 41. Mean catch per half-hour trawling (number of fish) and age composition (%) of whiting caught by the F.R.S. "Anton Dohrn" in the North Sea in September/October 1957

(Herring trawl)

Age-group	Year-class	Fladen Ground	Dogger Bank/ Gut	German Bight
0	1957	266 (25)	47 (11)	163 (16)
I	1956	140 (13)	44 (10)	305 (29)
II	1955	583 (54)	314 (73)	551 (53)
III	1954	79 (7)	24 (6)	26 (2)
IV+	1953+	1 (1)	+ (+)	1 (+)
All ages		1,069 (100)	429 (100)	1,046 (100)
Trawl stations .		4	21	16

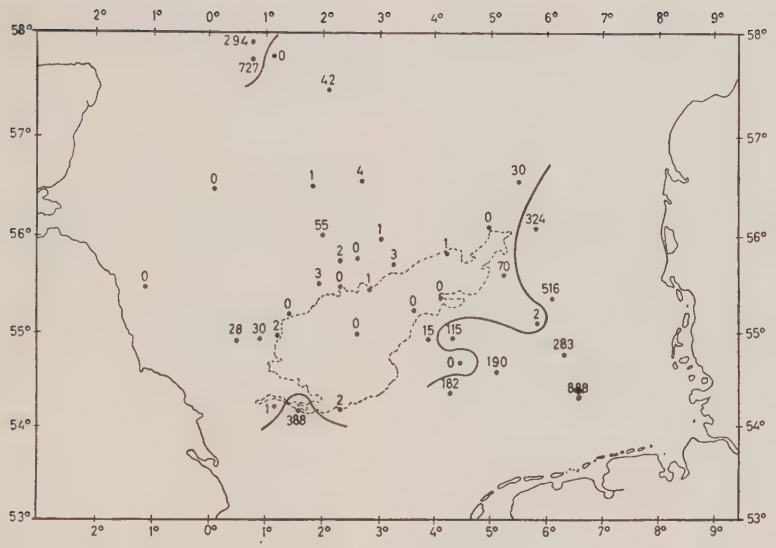

Figure 27. Catches of 0-group whiting (1957 year-class) per half-hour trawling with the F.R.S. "Anton Dohrn" during September/October 1957 (herring trawl). The isoline of 100 whitings caught per half-hour haul is also shown.

Table 40. Mean lengths (cm.) of whiting caught by the F.R.S. "Anton Dohrn" in the north-eastern North Sea and the Skagerak in January/February 1957

(Herring trawl)

		Viking Bank/Utsira			Ling Bank 100–220 m. depth			Ling Bank < 100 m. depth			Skagerak		
Age-group	Year-class	Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish
0	1956	—	—	—	(20.2)	18—21	9	17.2	15—18	29	16.2	10—21	506
I	1955	26.7	21—33	43	27.4	22—32	42	24.0	19—30	114	25.2	19—31	115
II	1954	30.4	24—36	73	30.8	23—38	60	27.9	22—34	29	31.0	25—35	35
III	1953	33.6	29—43	72	33.9	28—43	64	(32.0)	30—33	2	33.4	29—39	10
IV	1952	36.7	30—45	32	36.7	31—50	21	—	—	—	(38.0)	35—40	2
V	1951	(40.0)	37—42	2	(44.0)	44	1	—	—	—	—	—	—
VI	1950	—	—	—	(40.0)	40	1	—	—	—	—	—	—

Table 42. Mean lengths (cm.) of whiting caugth by the F.R.S. "Anton Dohrn" in the North Sea in September/October 1957

(Herring trawl)

		Fladen Ground			Dogger Bank/Gut			German Bight		
Age-group	Year-class	Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish
0	1957	13.5	9—18	695[1])	12.9	9—18	921[1])	12.4	7—17	144
I	1956	25.9	23—28	318[1])	24.6	21—27	512[1])	22.6	18—27	93
II	1955	28.6	24—33	18	27.5	23—32	27	26.1	20—33	102
III	1954	(31.2)	30—31	3	(33.5)	32—34	2	31.8	25—39	6
IV	1953	35.1	30—39	8	(38.7	35—42	5	—	—	—

[1]) Only few age determinations (otoliths), interpolation according to length measurements.

Data on the mean catch per unit effort from experimental trawling are given by rectangles in Figures 20 and 21, page 134. The data worked up in September/October show that the stock density of whiting reached its highest level both in the north-western and south-eastern area of the North Sea, whereas the intermediate area (the Gut and the Dogger Bank) seemed to be less populated by this species (see also Table 41). This latter assumption is also supported by the distribution pattern of the 0-group whiting (1957 year-class) in relation to space (Fig. 27). In autumn 1957 the catch per unit effort of 0-group whiting was high in both the areas mentioned, whereas the intermediate area, Gut and Dogger, yielded small catches only.

In Tables 40 and 42, data on the mean lengths of whiting belonging to different year-classes are given. Table 40 shows that the differentiation of the year-classes by depth, mentioned above, seems to be accompanied by a difference in mean length of fish within the same age-group. In the Ling Bank area the smaller fish were found in the shallower waters, while it was possible to catch large fish of the same age at greater depths. It is, however, not possible to conclude whether the large whiting of the same year-class as small specimens have had more favourable growth conditions than those, or whether they belong to another population with a higher growth-rate.

D. Sahrhage

Herring

INTRODUCTION

Contributions to this report (9th) of the Herring Committee have been received from:—

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Scotland:
J. G. Baxter
J. D. Buchan
G. McPherson
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Alan Saville

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I. Udanov

I. C. E. S.:
Olav Aasen

In the Distant Northern Seas, the Icelandic contribution deals, amongst other observed facts, with characteristic changes in the composition of the herring caught off North Iceland in the summer of 1957. Also the returns of tagged herring differ from the earlier observations. The future development should be watched with scrutiny. Attention may also be drawn to the somewhat altered hydrographical conditions in the north-western part of the Norwegian Sea in early summer.

For the Near Northern Seas, the well composed and detailed Scottish account again sets a fine example for regular contributions to the Annales. It is interesting to note that while in the northern North Sea there seems to be a fairly high abundance of herring with good catches, the yield in the southern North Sea remains poor. During the summer of 1957 a step was taken towards establishing the fishing mortality of the industrial fishery for immature herring at Bløden Ground and its general effects on the other herring fisheries in the North Sea. The initial results seem promising. It is of outstanding importance that the same countries which participated in 1957 have agreed to support the continuation of this work also in 1958.

In the Baltic-Belt Seas the Swedes have continued their interesting herring tagging experiments, throwing new light on the migrations of herring in this area.

Olav Aasen

A. Distant Northern Seas

COMMERCIAL FISH

Soviet Investigations on the State of the Stock, Distribution, and Behaviour of Herring in the North Atlantic

Early development of plankton was observed in the Norwegian Sea in 1957 (E. A. Pavshtiks, L. N. Gruzov). The basic feeding organism of the herring — *Calanus* — descended at an early date to the deeper layers of the central Norwegian Sea, thus depleting the supplies of feeding-plankton in the upper layers in summer. Mass development of medusae in June has also contributed to the decrease.

Diurnal observations on the vertical distribution of plankton in waters of the polar front showed that the upper 50 metres, where maximum plankton biomass is present from 21 to 03 hours, is of major importance from the point of food supply.

The age data confirmed the forecast for 1957 with respect to the importance of the basic year-classes in the catches. The only exception was the 1953 year-class which failed to comply with the initial assessment of its strength as a rich brood, and produced rather insignificant recruitment to the commercial stock.

It was supposed that the 1953 year-class, having reached by 1957 the age of four years, would leave the shores in large numbers and by dispersing into the open sea appear in abundance in the Soviet

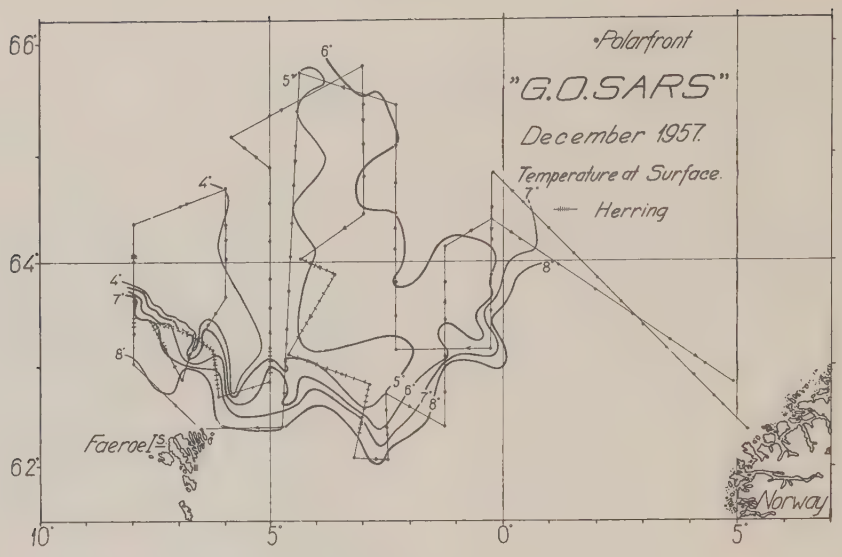


Figure 1. Surface temperatures and herring schools, December 1957.

fisheries. However, in spite of a thorough survey of the north-eastern Norwegian Sea during a special cruise of the R/V "Akademik Berg", no commercial concentrations of herring of this year-class were found in the area in July—August.

Forecast of the herring fisheries for 1958, based on a general assessment of stock conditions and on the results of investigations carried out in 1957, does not indicate a large-scale recruitment to the commercial stock from the younger generations. Therefore, as in 1957, herring of the 1951 and 1950 year-classes will still be very important in the catches while the 1950 year-class will be predominant throughout all the fishing seasons of 1958.

As both these year-classes have been heavily fished for the last four years, the general level of the stock is estimated to be lower than last year. Therefore the success of the fisheries will, as in 1957, depend largely on the concentrations of the herring.

Forecast for 1958 was given on the basis of an analysis of stock conditions (I. V. Korzh). It is brought to attention that the success of the fisheries during the year will chiefly depend on the abundance of the 1950 year-class, which is expected to be above average.

I. Udanov

Norwegian Herring Investigation in the Norwegian Sea, 1957

(Figure 1)

The R/S "G. O. Sars" under the leadership of Dr. Eggvin surveyed the Norwegian Sea in collaboration with Danish, Icelandic, and Soviet research ships in early summer (28. May—1. July). Dr. Eggvin sums up the results as follows:—

"The distribution of the temperatures this year is characterized by the fact that the transition area between the warm Atlantic water and the cold Arctic water is broader than usual. This feature is most conspicuous in the 'cold tongue' (East Icelandic Current) between Jan Mayen and Iceland penetrating in a south-easterly direction towards the Faroes. The reason for this abnormal situation is that the ice pack has withdrawn extensively in the area north and west of Jan Mayen and that the temperature there is about 2°C. above normal. A major part of the water in the 'cold tongue' originates in this area, and therefore the temperatures in the East Icelandic Current are higher than usual, especially in the north-western part. The thermocline (3—5°C.) is accordingly displaced towards the north-west compared to normal conditions, and it is in this transition area that the

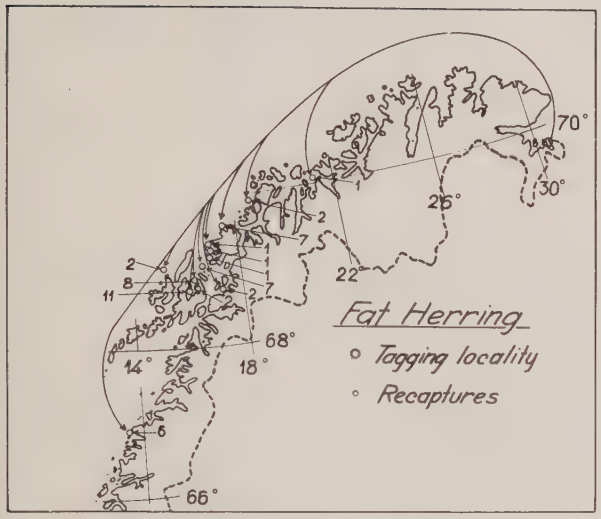


Figure 2.
Migration of tagged fat herring August—October 1957.

heaviest concentrations of herring have been observed this year (roughly between 65°—67° N.L. and 6°—12° W.L.)."

During December (3.—17.) a cruise with O. J. ØSTVEDT in charge was undertaken with the R/S "G. O. Sars" to the area north and north-east of the Faroes. The purpose of the cruise was to locate the Atlanto-Scandian herring approaching the Norwegian spawning grounds and to take hydrographical observations. Figure 1 shows the distribution of the surface temperatures. The hatchings indicate where herring schools were observed.

OLAV AASEN

Norwegian Fat Herring Tagging in 1957

(Figure 2)

The tagged number with dates and locality is included in Table 12 (Near Northern Seas, p. 158).

Figure 2 shows the long-distance migrations in 1957 of fat herring tagged in Jarfjord. The numbers of herring recaptured in each locality are marked out on the figure beside the symbol for recapture.

Nearly all the herring were recaught in October, only two months after liberation, and therefore a rapid migration southward from the tagging locality seems to have taken place just after the tagging. This southward migration in autumn is in agreement with previous tagging experiments of fat herring.

OLAV DRAGESUND

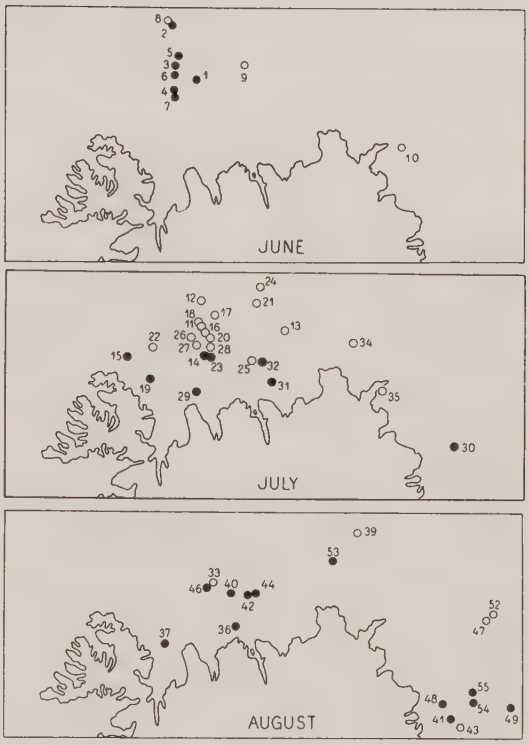


Figure 3. Localities of sampling in 1957.

The Icelandic North Coast Herring in 1957

(Figures 3–7; Tables 1–8)

More vessels participated in the herring fishery in 1957 than in the previous year, and the season began earlier. The participation was as follows:—

1956: 187 vessels, 14,380 gr. reg. tons
1957: 234 vessels, 18,592 gr. reg. tons

The total catch amounted to 987,609 hl. as compared with 760,848 hl. in 1956. This shows a very poor fishing season, the 13th in a series of bad years. The average catch per boat throughout the season was 4,042 hl. compared with 3,784 hl. in 1956, but it must be remembered that the season of 1957 was longer than that of 1956. The fishing started already on 20. June.

The material examined comprised 55 samples containing more than 5,100 fish. The localities from which the samples originated are shown in Figure 3. In June nearly all the catches came from the western part of the north coast, far off shore, whereas in July all catches were taken along the north coast, and, in August, also off the east coast. The composition data of the samples show

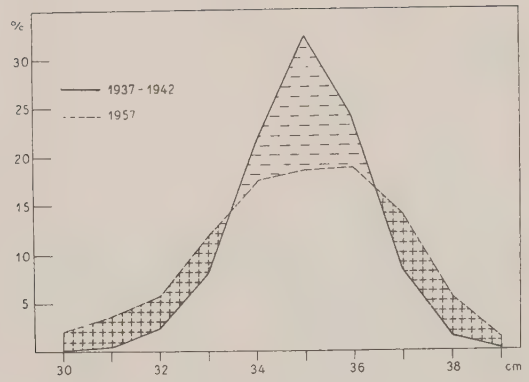


Figure 4. Size distribution of north coast herring in 1957 and 1937—1942.

a considerable difference (white and black circles in Figure 3) as will be explained later. The lengths can be seen in Table 1 in which the samples have been divided into groups according to length, age, and type. The black circles on Figure 3 indicate samples in which the Icelandic herring tribes are particularly predominating. They were characterized by less length and lower age and were mostly taken nearer the coast. The sample numbers are indicated both in the figure and in the table. The average length of the fish varied considerably from month to month, as follows (in cm.):—

	"White" samples		"Black" samples		Total	
	Ring-net	Drift-net	Ring-net	Drift-net	Ring-net	Drift-net
June	35.82	—	34.76	—	35.06	—
July	35.85	—	33.96	—	35.18	—
August	34.72	35.64	33.76	33.62	34.12	34.10
Total	35.64		34.04		34.96	

It appears from these figures that (1) the difference between the average lengths of the fish in the "white" and "black" samples amounts to 1.60 cm. and (2) that from July to August a sudden drop occurs in the average lengths.

The average length of all herring which were examined during the season proved to be 34.96 cm., or nearly one centimetre less than in 1956 (35.89) and 1955 (35.70). The average length corresponds to a certain extent to the average length during the period of good fishing from 1937 to 1942, when it was 34.92, but a glance at Figure 4 reveals that the size distribution is entirely different. In 1957 the main stock is partly lacking, whereas relatively more small and large fish are present than in 1937—42.

Samples 50—51 have no connexion with the main fishing, but are included for comparison. They originated from gill-net catches (August) in one of the fjords on the east coast and consisted mainly of small fish.

Table 1. Length distribution of north coast herring (‰)

	Purse-seine				Drift-nets					Gill-nets
	June		July		August		August		Total	Nos.
Sample Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.		50–51
	1–7	8–10	11–13 16–18 20–22 24–28 34–35	14–15 19, 23 29–32	38, 43 52	41, 48 54–55	33, 39 45, 47	36–37 40, 42 44, 46 49, 53		
Length, cm.										
41	—	—	1	—	—	—	—	—	+	—
40	—	3	5	—	—	—	3	—	2	5
39	1	23	32	5	4	—	6	—	12	—
38	13	80	116	39	25	21	60	10	55	—
37	60	227	**252**	72	123	92	190	46	140	5
36	218	**277**	199	124	**281**	**199**	**263**	109	**188**	—
35	**279**	244	181	146	196	147	160	157	186	**10**
34	268	83	116	**222**	128	126	150	**221**	174	5
33	137	40	66	168	98	104	90	202	119	75
32	17	10	20	105	64	95	45	124	58	100
31	6	3	8	65	38	**107**	21	70	35	120
30	1	**10**	4	31	26	61	12	40	20	120
29	—	—	—	15	13	18	—	15	7	175
28	—	—	—	6	4	21	—	5	3	**255**
27	—	—	—	1	—	9	—	—	1	95
26	—	—	—	—	—	—	—	1	+	35
25	—	—	—	1	—	—	—	—	+	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number of fish	700	300	1442	800	235	327	332	800	4936	200
Mean	34.76	35.82	35.85	33.96	34.72	33.76	35.25	33.62	34.96	29.51

Table 2. Relative strength of the tribes

Tribes	June	July	August	Total
NN	102	185	158	146
NS	14	57	67	52
ISPR	869	641	293	587
ISUM	15	117	482	215
Total	1000	1000	1000	1000
Number	929	2055	1427	4411

Table 3. Age of north coast herring in 1957

Age	Year	NN	NS	ISPR	ISUM	?[1])	Total
2	1955	—	—	+	—	—	+
3	1954	—	—	8	6	—	6
4	1953	6	—	52	101	63	53
5	1952	6	4	32	155	95	55
6	1951	62	32	91	**315**	143	132
7	1950	**146**	**134**	**282**	151	127	**225**
8	1949	24	4	**250**	**149**	—	180
9	1948	60	63	29	33	111	37
10	1947	**90**	**318**	23	24	95	49
11	1946	40	84	49	23	127	45
12	1945	87	27	**152**	**33**	—	**109**
13	1944	**90**	**84**	16	6	79	29
14	1943	**100**	**174**	2	1	16	25
15	1942	28	18	7	3	48	11
16	1941	37	23	3	—	32	8
17	1940	65	4	4	—	48	12
18	1939	51	**18**	—	—	—	8
19	1938	**54**	9	—	—	16	8
20	1937	**40**	4	—	—	—	6
21	1936	6	—	—	—	—	1
22	1935	8	—	—	—	—	1
Total		1000	1000	1000	1000	1000	1000
Number		631	224	2542	934	63	4394
?[2])		71	2	1	6	462	542
Grand total		702	226	2543	940	525	4936
‰		146	52	587	215	—	1000
Average age ...		12.3	11.0	8.2	6.7	—	8.6

[1]) Scales not fit for determination of type.

[2]) Scales not fit for age reading.

NN = North Norway type
NS = South Norway type
ISPR = Icelandic spring spawners
ISUM = Icelandic summer spawners

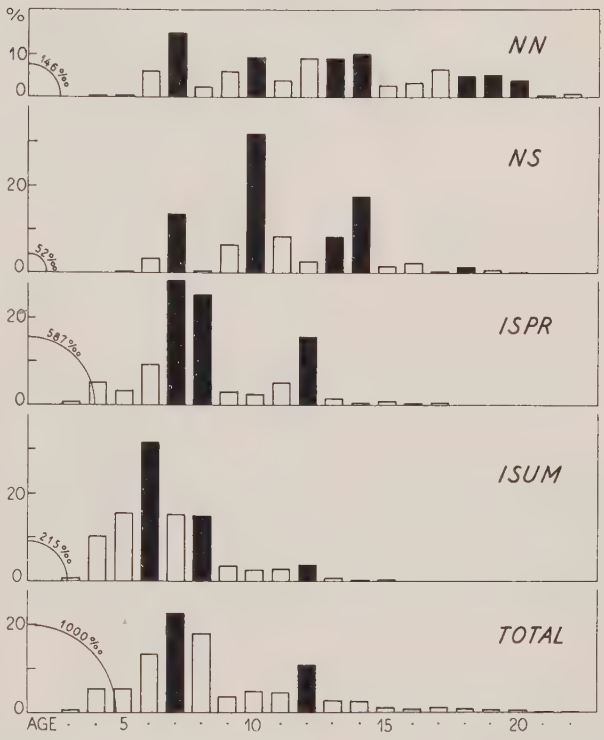


Figure 5. Age distribution in the different tribes and relative number of fish in each tribe (‰).

The composition as to tribes is shown in Table 2. It is immediately noticed that the Icelandic tribes contributed much more herring than in any earlier year covered by our investigations. In June, the Icelandic spring spawners provided the major bulk of the catches (86.9%) but a small quantity of summer spawners were also present. In July, relatively more herring of the Atlanto-Scandian type were found, but, at the same time, summer spawners appeared in increased numbers and the Icelandic spring spawners were still predominating, forming 64.1% of the catch, by number of fish. In August, summer spawners provided nearly half the catches (48.2%) which is much more than normal. The main feature of the season was, therefore: (1) an unusually low percentage of Norwegian herring, 19.8% as compared with 56.6% in 1956, and (2) an unusually large amount of summer spawners, 21.5% compared with 4.8% in 1956.

There were of course considerably more Norwegian herring in the "white" samples than in the "black", viz., 32.9% in June, 31.9% in July, and 41.9% in August. In these samples no summer spawners were found in June and July. The percentage of Norwegian herring in June, July, and August in the "black" samples were 2.9, 10.7, and 15.7, and the corresponding figures for the summer spawners were 2.1, 32.1, and 53.1.

Norwegian herring were not present in samples 50—51, which consisted of almost even numbers of Icelandic spring spawners (49.2%) and summer spawners (50.8%).

The age composition of the tribes of the north coast herring in 1957 is shown in Table 3 and Figure 5.

There were 21 broods in the catches, aged from 2 to 22 years. In the northern Norwegian tribe the same predominating year-classes were found

Table 4. North coast herring in 1957. Age composition in the groups of "black" and "white" samples
(See Figure 3)

	Purse-seine						Drift-nets			Gill-nets
	June		July		August		August		Total	August
Sample Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.		Nos.
	1–7	8–10	11–13	14–15	38, 43	41, 48	33, 39	36–37		50–51
			16–18	19, 23	52	54–55	45, 47	40, 42		
			20–22	29–32				44, 46		
			24–28					49, 53		
Age (Years)			34–35							
2	—	—	—	1	—	—	—	—	+	15
3	—	—	—	13	10	32	4	8	6	**526**
4	**6**	11	15	**105**	**66**	**148**	**67**	**100**	**56**	**220**
5	3	15	21	94	51	88	47	**134**	55	87
6	72	52	75	**172**	**97**	**162**	**95**	**290**	**130**	**87**
7	**376**	**176**	**181**	**296**	**174**	**148**	**153**	**185**	**226**	25
8	**319**	**169**	**193**	**155**	91	99	91	**150**	**181**	**25**
9	24	41	42	20	61	53	67	30	37	5
10	23	75	53	24	**92**	**81**	**102**	26	47	**15**
11	**66**	**109**	50	16	71	28	43	17	44	—
12	**100**	**154**	**158**	**63**	**122**	**71**	**157**	**41**	**108**	—
13	6	56	59	12	20	25	51	9	30	—
14	2	41	48	13	35	14	31	1	24	—
15	3	26	15	3	15	14	24	4	11	—
16	—	15	15	3	15	11	20	—	8	—
17	—	15	26	5	15	7	8	4	12	—
18	—	**19**	17	—	10	7	**16**	—	8	—
19	—	15	19	1	25	4	8	—	9	—
20	—	11	8	4	**25**	4	**12**	1	6	—
21	—	—	2	—	5	4	0	—	1	5
22	—	—	**3**	—	—	—	**4**	—	1	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	654	267	1298	743	197	283	254	664	4360	196
?	30	24	114	38	31	41	74	120	472	4
r	16	9	30	19	7	3	4	16	104	—
Grand total	700	300	1442	800	235	327	332	800	4936	200
Mean	8.2	10.1	10.1	7.2	9.5	7.6	9.5	6.9	8.6	3.9

as in 1956 and 1955, but the 1950 brood was relatively stronger than in 1956, whereas the old year-classes from 1937, 1938, and 1939 were much poorer, providing only 14.5% of the tribe in 1957 as compared with 37.1% in 1956. The average age in this tribe was accordingly only 12.3 years instead of 14.9 years in 1956. In the southern Norwegian tribe the age composition was similar to that of 1956 but the 1947-class was richer and, in general, more young and less old fish occurred. The average age was practically the same (11.0 years) as in 1956 (11.2 years). The age distribution in the Icelandic spring spawning tribe was similar to that of 1956, both years being predominated by the same year-classes. The only exception was the 1950 year-class which was much stronger in 1957 (28.2%) than in 1956 (14.0%). The average age in 1957 (8.2 years) was consequently somewhat lower than in 1956 (8.6 years). In the summer spawning tribe a lack of old fish and a relatively large amount of young fish were noted as a result of the scarcity of the 1945 brood. The brood from 1951 was comparatively rich (31.5%) and 4- and 5-year-old fish were also abundant. Consequently, the average age was much lower in 1957 (6.7 years) than in 1956 (9.0 years). The total shows an unusual predominance of the younger year-classes owing to the strong influence from the Icelandic tribes. This affected the average age of the whole stock of north coast herring being only 8.6 years, or much lower than in any previous period during more than 20 years of investigation. During some past years the average age has been as follows:—

Year	Average age (years)
1937—1942	11.5
1948—1955	11.9
1956	11.3
1957	8.6

Table 4 has been compiled in order to show the difference in age composition and the average age in the different groups of samples. It appears clearly that the "white" samples consist of proportionately more old herring than the "black".

Table 5. Total number of vertebrae by tribes

V.S.	NN	NS	ISPR	ISUM	?	Total
60	—	—	—	—	2	+
59	19	27	12	4	11	12
58	263	257	305	135	198	256
57	602	623	582	645	636	602
56	111	93	94	206	145	123
55	4	—	6	10	8	6
54	1	—	1	—	—	1
Total	1000	1000	1000	1000	1000	1000
Number	702	226	2543	940	525	4936
V.S.	57.18	57.22	57.18	56.92	57.07	57.14
± m	0.02	0.04	0.01	0.02	0.03	0.01

Table 6. Total number of vertebrae by maturity

	A			B				
Maturity	Number	V.S.	± m	VIII	VII	V	IV	III
II	90	57.16	0.07	0.3	3.4	3.3	0.5	0.4
III	1460	57.18	0.02	2.4	6.7	3.9	0.3	—
IV	124	57.20	0.06	1.1	4.1	3.7	—	—
V	24	56.67	0.13	3.5	0.8	—	—	—
VII	151	56.88	0.04	5.5	—	—	—	—
VIII	3087	57.13	0.01	—	—	—	—	—

In the two gill-net samples from the east coast (Nos. 50—51) 3- and 4-year-old fish were predominating, providing 74.6% of the total.

Turning now to the number of vertebrae (V.S.) a glance at Table 5 will give a survey of the distribution, etc. within the various tribes. In the northern Norwegian tribe the average number of vertebrae is a little lower (57.18) than in 1956 (57.20) but exactly the same as in 1955, and the average number in the southern tribe is higher (57.22) than in both 1956 (57.20) and 1955 (57.19). The Icelandic spring spawners showed a lower count (57.18) than in 1956 (57.26) and 1955 (57.22). Finally, the summer spawners showed a similar count (56.92) as in 1956 (56.94) and it was considerably higher than in 1955 (56.75). Owing to the relative strength of the summer spawners in the stock the total number of vertebrae for all tribes combined was lower in 1957 (57.14) than in 1956 (57.20).

Table 6 shows the number of vertebrae at the different stages of maturity. The figures in Table 6 B show the differences between the maturity groups. They indicate the difference in relation to the standard deviation of the difference between the groups compared.

It is evident that the herring at stages V and VII are entirely different from all the other groups. They must be composed of summer spawners appearing at stage V early in the season and at stage VII in August. Moreover, there is a considerable difference between the herring at stage III and that at VIII. As III is composed exclusively of spring spawners there must be a number of summer spawners at stage VIII. This fact is clearly revealed if we consider the survey in Table 7, where the herring at stage VIII in June, July, and August are compared.

Table 7. Comparison by months of herring at stage VIII

Month	Number	V.S.	± m	August	July
June	888	57.27	0.02	**9.6**	0.4
July	1113	57.21	0.02	**11.1**	—
August	1083	56.95	0.02	—	—

The 1,083 herrings at stage VIII encountered in August are entirely different from the herring at stage VIII in June and July, between which there is no difference.

During the first month of the season the feeding conditions were very good, but about the middle of July the amount of *Calanus* in the stomachs of the herring decreased very suddenly. The average amount of *Calanus* (cm.^{3}) per stomach throughout the season proved to be as follows:—

11.—20.	June	11.0
21.—30.	,, ...	9.1
1.—10.	July	10.5
11.—20.	,, ...	6.6
21.—31.	,, ...	3.4
1.—10.	August	0.9
11.—20.	,, ...	none
21.—31.	,, ...	none

During the latter part of the season *Calanus* was replaced to some extent by euphausids but mainly by sand-eel larvae (*Ammodytes*).

Owing to the good feeding conditions at the beginning of the season the amount of intestinal fat increased rapidly and then decreased suddenly, being 1.5 in June, 1.9 in July, and 1.3 in August (scale: 0, 1, 2, 3). The average was 1.6. The very marked decline in August was, no doubt, due mainly to the immigration of summer spawners. The great number of summer spawners and the very low quantity of intestinal fat in August were quite exceptional. Normally, the index of intestinal fat is higher in August than in July as appears from the following survey for the last 20 years.

1938—1940	Index	23%	higher	in	August	than	in	July
1941—1944	,,	16%	,,	,,	,,	,,	,,	,,
1945—1948	,,	3%	,,	,,	,,	,,	,,	,,
1949—1952	,,	2%	,,	,,	,,	,,	,,	,,
1953—1956	,,	9%	lower	,,	,,	,,	,,	,,
1957	,,	32%	,,	,,	,,	,,	,,	,,

It may be noted that the years 1938—1944 represent a rich fishing period and 1945—1957 a poor one.

Figure 6. Migration of herring from North Iceland to the Fladen Ground.

Figure 7. Localities of taggings in 1957.

The maturity factor for all spring-spawning herring was found to be 1.6, or a little lower than in the seasons of 1952—1956. The relative number of fish where the maturity factor exceeded 5 was 3.5%, or exactly the same as in 1955.

Tagging

The records of returns can be seen from Table 8.

Table 8. Returns of tagged herring in 1957

Year of tagging	Tagging locality N. coast	E. coast	S.W. coast	Norway	Total
1948	2	—	—	1	3
1949	—	—	—	—	—
1950	—	—	—	1	1
1951	6	—	—	2	8
1952	30	—	—	1	31
1953	63	—	8	1	72
1954	98	—	8	1	107
1955	56	6	—	—	62
1956	130	—	1	1	132
1957	92	—	—	—	92
Total	477	6	17	8	508

Referring to earlier reports in the *Annales Biologiques* it appears from the table that many more tags were returned in 1957 than in any previous year. The number of north coast tags returned from factories in North Iceland since the tagging experiments were started in 1948 have been as follows:—

1948	21 tags	1953	150 tags
1949	49 ,,	1954	117 ,,
1950	11 ,,	1955	35 ,,
1951	30 ,,	1956	244 ,,
1952	4 ,,	1957	477 ,,

Altogether, 1,138 north coast tags have been found. When we compare the relatively large number of north coast tags found in 1957 (477) with the records from 1956 (244 tags) it must be remembered that only 461,386 hectolitres were processed in 1956 as compared with 775,662 hectolitres in 1957. If we calculate the average number of tags returned from each 100,000 hectolitres processed, we have almost exactly the same figure for both years, 49.9 tags in 1956 and 49.6 in 1957, if the returns from the taggings of 1956 and 1957, respectively, are omitted.

It is very interesting to note that 17 tags were returned from the taggings off the S.W. coast. This fact underlines clearly the rather intensive migration of herring from south to north Iceland during this exceptional season.

In spite of the greater quantity of herring processed there were much less Norwegian returns (8) than in 1956 (17). The number of tags per 100,000 hectolitres were therefore 3.7 in 1956 and 1.0 in 1957, in good agreement with the much smaller proportion of Norwegian herring in the catches (56.6% in 1956 and 19.8% in 1957).

During the spring of 1957, 300 north coast tags were reported from Norway. Altogether, 2,380 north coast herrings have now been returned from Norway, the records from 1957 included.

Returns of tagged north coast herring in 1957 were, however, not only reported from Norway, as 3 tags came from Swedish catches taken on the Fladen Ground about the middle of August. One of the fish had been tagged off North Iceland in 1954 and the other two in the same place in 1955. The herrings have probably migrated to Norway and from there to the Fladen Ground (see Figure 6).

During 1957, 12,776 herrings were tagged in Iceland, 7,550 of which were liberated off the north and east coasts. For tagging localities, see Figure 7.

ÁRNI FRIÐRIKSSON

B. Near Northern Seas

YOUNG STAGES

Autumn Spawned Herring Larvae in the Northern North Sea

Scottish research vessels in 1957 carried out a series of cruises to sample the herring larvae, spawned in the autumn, in the northern North Sea. The area sampled extended from 57°50′ N. to 53°50′ N. and from the Scottish coast to 3° E. The cruise periods were 12.—18. August, 2.—18. September, 4.—20. October, 3.—15. November, and 23. November—5. December.

On the first of these cruises small newly hatched larvae were located at two stations on the south-west corner of Aberdeen Bank. No larvae were taken elsewhere on a very intensive station-grid. On the following cruise larvae were widely spread over an area extending to the prime meridian to the east, and to 56° N. to the south. Although in size they ranged up to a length of 23 mm., the overwhelming proportion were of less than 10 mm., and numbers were small except at stations on the western edge of Turbot Bank, in a strip close to the coast off Buchan Ness, on Aberdeen Bank, and most particularly, on Montrose Bank where active hatching was in progress.

By the time of the October cruise larvae were widespread out to 1° E., and southwards to 55°30′ N. There were still signs of hatching in progress, although on a reduced scale, in an area to the north-east of Kinnaird Head, on Aberdeen Bank, and to the east of the Longstone. The modal size of larvae on this cruise, however, was 14 mm., and these larger larvae had their greatest abundance in a band between 0°30′ W. and 1°30′ W. extending southwards to 55°30′ N.

In November the survey was considerably curtailed by bad weather, no sampling being carried out east of the prime meridian or south of 56° N. Hatching was by then over. The greatest concentration of larvae was located off the Aberdeenshire coast in a patch extending eastwards to the limit of the area sampled.

On the last cruise larvae were much less abundant and ranged in size up to 35 mm. Three dinstinct concentrations could be distinguished—one off the Scottish coast extending eastwards to 2° E., and with the greatest abundance between 0° E. and 1° W.; rather smaller ones off the Tyne, and on the south-west corner of the Dogger.

Three aspects of this year distinguish it from the others for which we have comparable data. Firstly, the dominant position attained by Montrose Bank as a spawning centre, rather than Turbot Bank as in other years; secondly, the rather low level of larval abundance maintained throughout the entire season; and thirdly, the more marked easterly drift of larvae than has been observed previously.

Alan Saville

COMMERCIAL FISH

Hydrographical Conditions and Occurrence of Herring during the Spawning Migration to the Norwegian Coast in January 1957

(Figure 8)

During January 1957 the R/S "G. O. Sars" was engaged in locating herring schools and making hydrographical observations in advance of and during the spawning influx. The results of the survey work is compiled in Figure 8. A remarkable feature is the northerly displacement, compared to earlier years, of the main influx. It is also worth noting that the first break through of the warm water front took place where the water was coldest (i.e., a little south of 64° N. L.).

Olav Aasen

Figure 8. Temperatures in 30 m. and located herring schools in January 1957.

Length, Age, and Spawning Groups of the Norwegian Winter Herring, 1957

(Tables 9–11)

The winter herring season 1957 lasted from 14. January to 4. April, in all 69 fishing days. The total catch landed in Norway was 8.5 mill. hl., a reduction of 31% from 1956. The landings by drift-nets were the same as in 1956, and the declien in the yield was due to poor catches of the purse-seiners, probably caused by unusually bad weather during January and the first week of February.

Sampling of the landings for age, length, maturity, and Vert. S. was conducted along the same lines as in previous years. During the season 37 samples containing 6,313 herrings were investigated. The length and age composition of the samples from the purse-seine and the drift-net landings are shown in Tables 9 and 10. The distribution of spawning groups is given in Table 11. The samples from the drift-net landings are unfortunately very few and cover only a part of the season, viz. three weeks in February.

The data show that the 1950 year-class was, as expected, even more predominant than in 1956, constituting 624‰ of the population sampled (in 1956, 587‰).

The first-time spawners of the 1950 year-class increased from 387‰ in 1956 to 420‰ in 1957. The main part of this year-class, which is now seven years old, has reached maturity and we must expect that the recruitment of first-time spawners (of the 1950 year-class) will be considerably reduced the next year.

Table 9.

Length composition of Norwegian winter herring (‰)
A: Stages IV—VIII; B: Total (including stages I—III and herring with scales not fit for age determination).

	A		B	
cm.	Purse-seine	Drift-net	Purse-seine	Drift-net
22.0	—	—	1	—
.5	—	—	2	—
23.0	—	—	2	—
.5	—	—	4	—
24.0	0.5	—	9	—
.5	—	—	6	—
25.0	—	—	5	—
.5	0.5	—	4	—
26.0	1	—	5	—
.5	1	—	4	—
27.0	4	—	8	—
.5	7	—	11	2
28.0	28	11	33	10
.5	35	18	42	21
29.0	60	72	62	72
.5	44	41	45	42
30.0	42	70	41	67
.5	20	29	20	28
31.0	31	40	29	45
.5	39	59	35	61
32.0	97	104	87	101
.5	90	118	78	118
33.0	119	161	106	155
.5	80	79	71	82
34.0	67	78	60	75
.5	34	35	32	34
35.0	36	30	36	31
.5	35	6	35	6
36.0	55	24	53	25
.5	31	11	31	10
37.0	28	6	28	6
.5	7	5	7	6
38.0	5	3	5	3
.5	2	—	2	—
39.0	1	—	1	—
Total	1000	1000	1000	1000
Number	4,694	628	5,525	761

The younger year-classes, 1951, 1952, and 1953, are poor, and the recruit spawners of these year-classes will probably not appear in sufficient numbers to replace the older year-classes. We may therefore expect that the stock of mature winter herring will be reduced in the coming years.

O. J. Østvedt

Table 10. Age composition of Norwegian winter herring maturity stages IV—VIII (‰)

	Purse-seine			Drift-net		
Age	N.type	S.type	Total	N.type	S.type	Total
3	—	2	1	—	4	2
4	3	70	26	—	180	73
5	3	117	43	—	183	75
6	23	110	54	40	168	92
7	701	481	623	791	401	632
8	15	36	23	24	12	19
9	43	18	34	32	8	22
10	30	33	31	32	16	25
11	18	28	22	—	4	2
12	26	39	30	8	12	10
13	37	36	37	19	8	14
14	19	22	20	8	—	5
15	8	5	7	3	—	2
16	11	2	8	5	—	3
17	14	1	9	16	—	9
18	21	—	14	11	—	6
19	15	—	10	5	—	3
20	7	—	4	—	4	2
21	5	—	3	—	—	—
22	1	—	0.5	3	—	2
23	—	—	0.5	—	—	—
24	—	—	—	3	—	2
Total	1000	1000	1000	1000	1000	1000
Number	3,044	1,650	4,694	372	256	628
Scales not fit for age determination	—	—	373	—	—	41
Immature (Stages I–III)	—	—	458	—	—	2

Table 11. Distribution of spawning groups of Norwegian winter herring (‰)

Spawning groups	Purse-seine	Drift-net
I	333	393
II	90	118
III	217	235
IV	153	172
V	27	14
VI	17	8
VII	23	16
VIII	33	5
IX	35	10
X	19	6
XI	13	10
XII	14	5
XIII	13	3
XIV	9	2
XV	3	3
XVI	0.5	—
XVII	0.5	—
Total	1000	1000
Number	4,643	618

Norwegian Herring Tagging Experiments in 1957

(Tables 12–13)

The herring tagging work in Norway was continued in 1957 and four categories of herring were tagged at different places along the coast. The number and categories tagged are listed in Table 12.

During the tagging experiments of spring herring this season successful attempts were made to take scales of each herring which was tagged with an internal steel tag.

With some experience it is possible for the tagging team to tag and take scales of 1200 herring per day. The mounting of the scales, however, was undertaken by another team on board the ship.

In Table 13 is given a summary of recoveries from reduction plants with tested magnets for the different experiments; the within season recoveries are not included. It will be noticed that the large herring tagged in 1955 and 1956 yield about the same per mille returns per million hectolitres as the spring herring.

Another interesting observation is the rather high per mille returns of spring herring tagged in 1948.

Table 12. Large herring, spring herring, "forfangstsild", and fat herring taggings in 1957

Area	Date	Number of liberations	by type of tag
Large herring			
Fanöyvåg (W. of Florö) ...	5.–14. II.	9500	(internal)
Spring herring			
Nedstrand (S. of Haugesund)	7.–22. III.	9450	8450 internal 500 external 500 int. & ext.
"Forfangstsild"			
Breisund (W. of Ålesund)	29. IV–1. V.	2200	2000 internal 100 external 100 int. & ext.
Gjersvik (S. of Ålesund)	3.–4. V.	2000	1900 internal 50 external 50 int. & ext.
Fat herring			
Jarfjord (E. of Kirkenes)	19.–20. VIII.	2100	2000 internal 100 external

This indicates that the shedding and tagging mortality may be insignificant in at least some of the experiments.

OLAV DRAGESUND

Table 13. Number of returns from reduction plants with tested magnets for the different experiments and returns per million hectolitres in ‰ (in brackets)

Year of tagging	Category	Numbers tagged	Year of recapture 1950	1951	1952	1953	1954	1955	1956	1957
1948 ...	SH	6,018	14 (1.30)	12 (0.74)	23 (0.87)	15 (0.74)	15 (0.43)	8 (0.35)	11 (0.34)	10 (0.44)
1948 ...	OH	7,475	9 (0.67)	7 (0.35)	9 (0.28)	9 (0.36)	12 (0.28)	0 (0.00)	1 (0.03)	2 (0.07)
1949 ...	SH	8,261	26 (1.75)	22 (0.98)	25 (0.68)	17 (0.61)	44 (0.92)	16 (0.41)	21 (0.50)	10 (0.31)
1950 ...	LH	9,085	—	14 (0.57)	14 (0.35)	10 (0.33)	16 (0.31)	9 (0.21)	11 (0.22)	5 (0.14)
1950 ...	SH	11,215	—	9 (0.30)	9 (0.18)	8 (0.21)	12 (0.19)	5 (0.13)	4 (0.07)	1 (0.04)
1950 ...	OH	1,827	—	10 (2.03)	16 (2.00)	13 (2.10)	13 (1.23)	8 (0.95)	7 (0.71)	2 (0.28)
1951 ...	LH	5,998	—	—	23 (0.87)	22 (1.08)	27 (0.78)	18 (0.65)	12 (0.39)	2 (0.09)
1951 ...	SH	9,986	—	—	63 (1.41)	60 (1.77)	68 (1.18)	57 (1.24)	38 (0.81)	29 (0.75)
1951 ...	OH	5,076	—	—	55 (2.48)	54 (3.14)	84 (2.86)	32 (1.32)	33 (1.20)	13 (0.66)
1952 ...	LH	10,295	—	—	—	18 (0.52)	26 (0.44)	14 (0.29)	13 (0.24)	7 (0.14)
1952 ...	SH	10,763	—	—	—	73 (2.00)	107 (1.72)	137 (2.76)	111 (1.89)	84 (2.05)
1952 ...	OH	17,308	—	—	—	246 (4.19)	328 (3.27)	116 (1.45)	109 (1.16)	65 (0.97)
1953 ...	LH	10,080	—	—	—	—	19 (0.33)	8 (0.17)	10 (0.18)	10 (0.26)
1953 ...	SH	10,046	—	—	—	—	37 (0.64)	47 (1.01)	37 (0.69)	35 (0.90)
1953 ...	OH	10,181	—	—	—	—	274 (4.66)	102 (2.24)	118 (2.15)	48 (1.21)
1954 ...	LH	10,042	—	—	—	—	—	24 (0.51)	18 (0.35)	14 (0.36)
1954 ...	SH	10,291	—	—	—	—	—	86 (1.81)	81 (1.46)	62 (1.52)
1954 ...	OH	8,783	—	—	—	—	—	122 (2.93)	87 (1.84)	47 (1.38)
1955 ...	LH	10,045	—	—	—	—	—	—	89 (1.65)	55 (1.41)
1955 ...	SH	9,087	—	—	—	—	—	—	28 (0.57)	32 (0.93)
1955 ...	OH	11,732	—	—	—	—	—	—	161 (2.56)	87 (1.90)
1956 ...	LH	4,998	—	—	—	—	—	—	—	29 (1.48)
1956 ...	OH	8,443	—	—	—	—	—	—	—	96 (2.92)

LH = Large herring
SH = Spring herring
OH = Open ocean and north coast herring

Table 14. Statistics of "halflin" fisheries 1952—1957

Season	1952–53	1953–54	1954–55	1955–56	1956–57
Upper Moray Firth					
Duration of season	13/9/52–21/3/53	12/9/53–20/3/54	18/9/54–26/3/55	1/10/55–31/3/56	6/10/56–9/2/57
Number of landings	1,631	2,654	1,715	2,989	2,274
Total catch (crans)	38,885	61,773	25,263	61,945	34,605
Catch/landing (crans)	23.8	23.3	14.7	20.7	15.2
Upper Firth of Forth					
Duration of season	4/10/52–21/3/53	26/12/53–10/4/54	18/10/54–23/3/55	24/9/55–31/3/56	8/9/56–16/3/57
Greatest number of boats engaged	31	29	22	16	16
Estimated catch of "halflins" (crans)	2,513	13,554	786	379	328

Table 15. Length and mean Vert. S. of 0- and I-group herring caught in the inshore waters off the Scottish east coast 1956—1957
(Numbers in brackets)

Locality	Date	Range (cm.)	Mean length (cm.)	Mean Vert. S.
Autumn 1955 and spring 1956 broods				
Firth of Forth	Dec. 1956[1])	8–15	11.00 (184)	56.29 (24)
	Jan. 1957[1])	8–15	11.54 (136)	56.69 (52)
Autumn 1954 and spring 1955 broods				
Firth of Forth	Jan. 1957[1])	15–22	17.93 (168)	56.57 (117)
	Feb. 1957[1])	16–22	18.60 (50)	56.59 (50)
Upper Moray Firth	Oct. 1956[2])	19–21	20.26 (95)	56.54 (91)
	Nov. 1956[2])	17–24	20.58 (666)	56.58 (349)
	Dec. 1956[2])	17–24	20.58 (415)	56.58 (261)
	Jan. 1957[2])	18–24	20.64 (441)	56.53 (355)
	Feb. 1957[3])	16–23	18.95 (498)	56.48 (188)

[1]) Samples caught by ring-net.
[2]) Samples caught by drift-net.
[3]) Samples caught by trawl.

0- and I-Group, Scotland, 1956—1957

(Tables 14–15)

There was no improvement in the landings of "halflins" from the ring-net fishery in the upper reaches of the Firth of Forth during the winter of 1956—57 compared with the previous winter. The drift-net fishery for "halflins" in the upper Moray Firth was much less successful during the winter of 1956—57 than during the previous winter and finished in February 1957 more than a month earlier than had been the custom since the winter of 1951—52. The landings and crude effort statistics for these fisheries for the years 1952—57 are given in Table 14.

The size-range, mean lengths, and mean Vert. S. of the samples of 0- and I-group herring from the commercial fisheries and from trawl catches by research vessels are given in Table 15. From the vertebral counts it appears that autumn-spawned herring predominated among both 0- and I-group herring.

G. McPherson

Scottish Fisheries 1957

(Figures 9–13; Charts 1–12; Tables 16–26)

A. North Sea

Commercial Landings

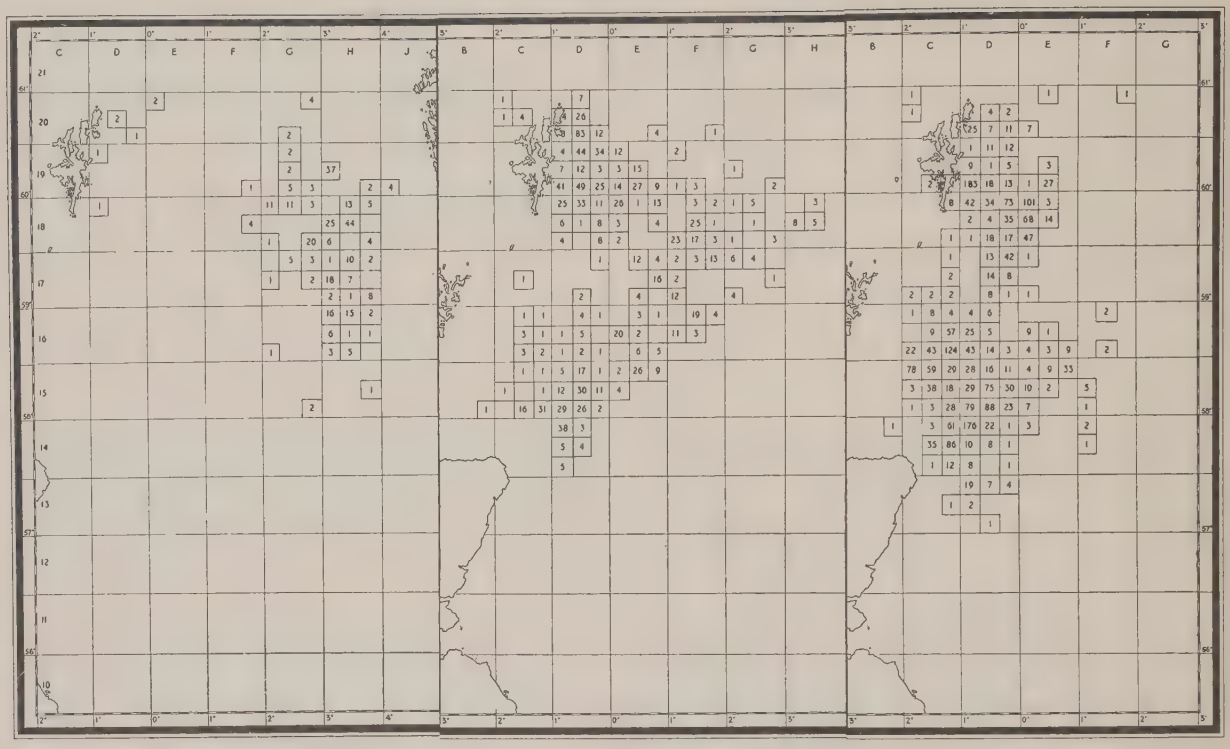
Drift-net

Drift-net fishing was carried out in the North Sea during 1957 from the following Scottish ports: Aberdeen (March to mid-September), Fraserburgh and Peterhead (April to mid-September), and Lerwick (May to August). There was also a small number of landings at Wick.

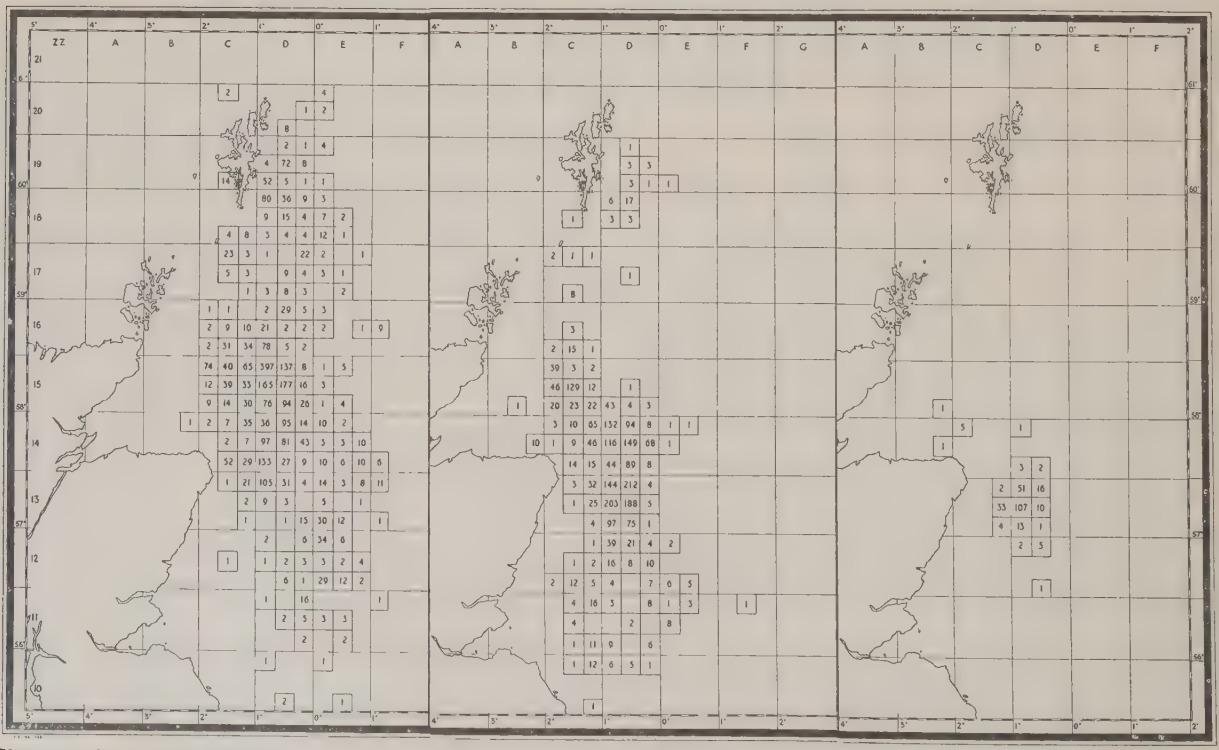
The catch and effort statistics for the fisheries from these ports for 1957 and the previous three years are given in Table 16 and the detailed statistics of catch and effort for each month in 10 mile squares for all fisheries combined are shown in Charts 1—12. Charts 1—6 give the total number of hauls in each 10 mile square (10′ latitude by 20′ longitude), and Charts 7—12 the average catch per 100 nets per haul for the same squares.

Despite an increase in fishing effort the total landings at Fraserburgh and Peterhead were lower than in 1956. The landing per arrival figures for the Lerwick and Aberdeen fisheries were of the same order as in 1956. This suggests that the average density of the available stocks for the whole season was at about the same level as in the previous three years at Shetland and on the offshore grounds but less on the local grounds fished by the Fraserburgh and Peterhead fleets.

Number of Hauls

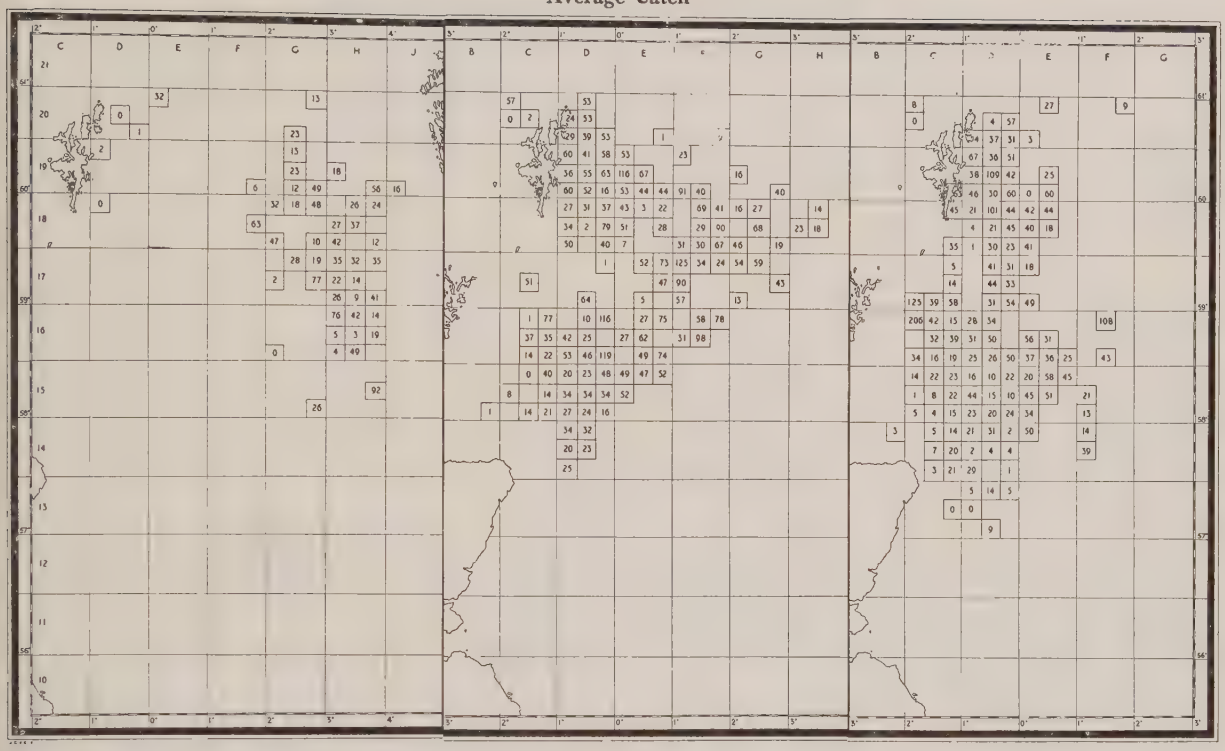


Charts 1–3. March–April May June

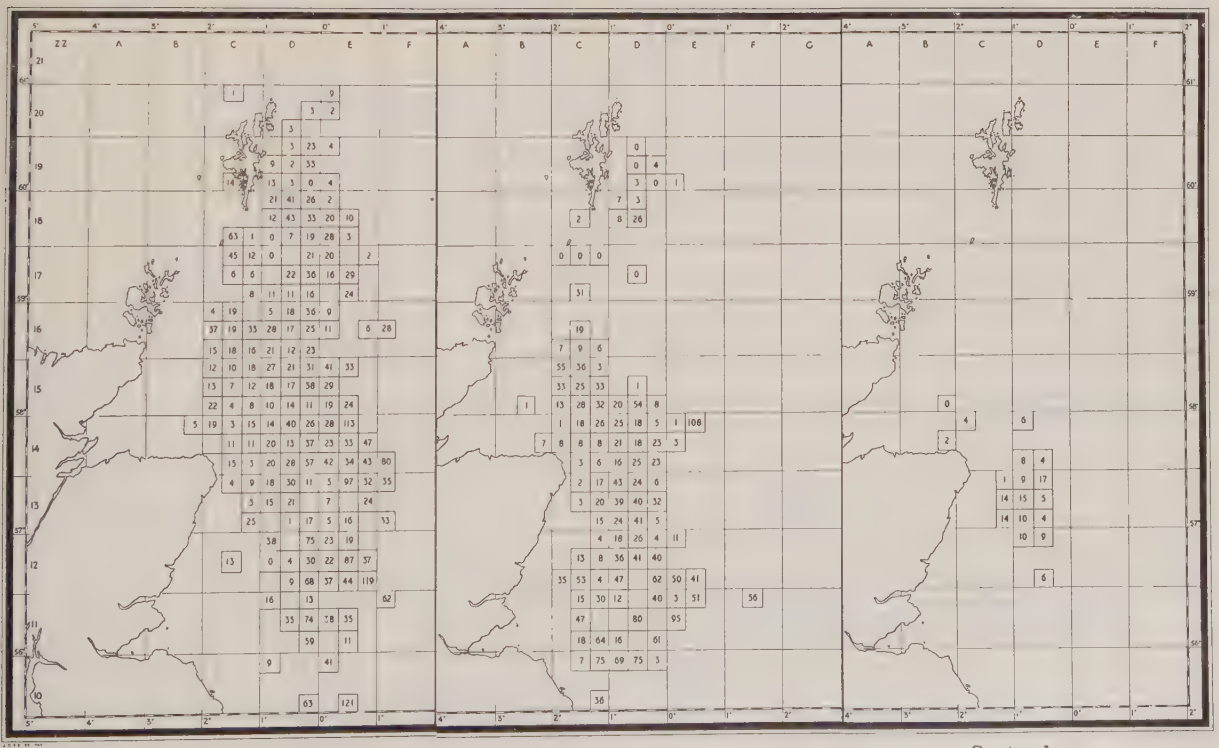


Charts 4–6. July August September

Average Catch



Charts 7–9. March–April May June



Charts 10–12. July August September

Table 16. East coast and Shetland landings, 1954—57

Drift-net

	Landings (crans)				Arrivals				Average landing per arrival[1] (crans)			
	1954	1955	1956	1957	1954	1955	1956	1957	1954	1955	1956	1957
Fraserburgh ...	147,817	171,462	84,831	75,704	6,630	5,740	3,811	4,226	22.3	29.9	22.3	17.9
Peterhead	87,218	89,454	54,337	50,014	3,570	2,984	1,720	2,334	24.4	30.0	31.6	21.4
Lerwick	23,382	43,216	42,019	39,380	1,664	1,733	1,966	1,483	14.1	24.9	21.4	26.6
Wick	4,894	2,614	2,325	44	242	74	57	11	20.2	35.3	40.8	4.0
Aberdeen	61,499	73,041	58,996	60,939	1,000	959	858	950	61.5	76.2	68.8	64.2

Trawl

	Landings (crans)				Hours fishing				Landing per 100 hours (crans)			
North-eastern North Sea ...	681	948	1,254	959	172	121	310	310	395.9	783.5	404.5	309.4
Fladen	3,869	1,268	2,721	906	1,502	311	1,269	400	257.6	407.7	214.4	226.5
Gut and southwards ..	12,057	10,912	4,625	6,199	2,871	3,090	1,850	2,136	420.0	353.1	250.0	290.2

[1]) These figures are not adjusted to standard number of nets per haul. Each arrival at Aberdeen represents on average two hauls. Each arrival at other drift-net ports usually only one haul.

Trawl

Occasional landings of trawled herrings from the north-eastern North Sea were made at Aberdeen in March, April, August, September, and November. Regular landings from the Gut grounds and a few from Fladen were made between July and November. Almost all the landings were made by Swedish vessels.

The catch and effort statistics for these trawl fisheries are given in Table 16. These show that the density of the available stock on the Fladen and Gut grounds was at about the same level as in 1956.

Length, Age, and Racial Composition of Samples

Sampling of the drift-net landings at Aberdeen, Fraserburgh, Peterhead, and Lerwick was carried out as in previous years.

North-eastern North Sea (grounds east of 1°E.)

The length and age composition of the samples taken in the north-eastern North Sea during April and May 1957 are shown in Figure 9; the maturity and Vert. S. data are given in Table 17, and the analysis of otolith characters in Table 18.

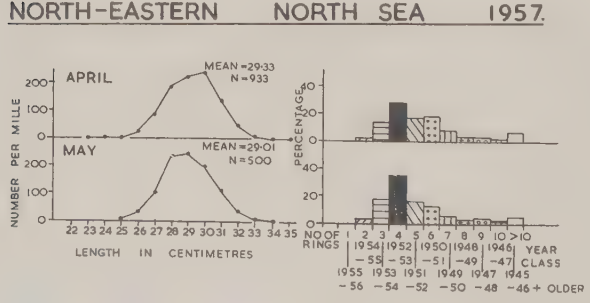


Figure 9. Length and age composition of north-eastern North Sea drift-net samples April—May 1957. (Length frequencies unsmoothed).

These data show that the composition of the stock sampled was similar to previous years (Ann. Biol., Vols. XII—XIII) with spring spawners, mostly showing 3 to 6 winter-rings, constituting about 40% of the total catch. There was a wide range of ages among the autumn spawners, with 4-ringers dominant.

North-western North Sea (grounds west of 1°E.)

The statistical squares sampled in each month were:—

	Lerwick											
May	D 20	D 19	E 19			D 18						
June	D 20	D 19				D 18	E 18			D 17		
July		D 19			C 18	D 18			C 17			
Aug.		D 19				D 18			C 17			

	Aberdeen				Fraserburgh				Peterhead			
May	D 19	D 18	E 17		C 16							
	D 16	E 16	D 15		C 15	D 15	D 14		C 15	D 15	D 14	
June	D 19	E 19			C 16							
	D 18	E 17			C 15	D 15				D 15		
	D 17	E 16	D 15		C 14	D 14			C 14	D 14	D 13	
July	E 18	D 17	D 16			D 16			C 16	D 16		
	C 15	D 15	E 15		C 15	D 15				D 15		
	D 14	E 14	E 13			D 14			C 14	D 14		
	E 12	E 11	E 10			D 13			C 13	D 13		
Aug.	E 14	D 13	D 12		C 15				C 15	D 15		
	E 12	C 11	D 11			D 14				D 14		
		C 10	D 10			D 13	D 12		C 13	D 13		
Sept.		D 13			C 14	C 13	D 13			D 13		

The length and age composition of the samples from each port are shown in Figure 10 and the maturity and Vert. S. data are given in Table 19.

Table 17. Maturity and racial characters — North-eastern North Sea, 1957

	A. Percentage Maturity (All age-groups) Maturity stage								B. Vert. S. (Actual numbers — all age-groups) Number of vertebrae							
	I	II	III	IV	V	VI	VII	VII-II	No.	54	55	56	57	58	59	Mean
April	2.1	1.4	0.4	0.1	0.1	4.2	**21.9**	**69.8**	933	—	21	284	491	105	9	56.78
May	4.0	**17.0**	0.4	—	—	0.4	**13.6**	**64.6**	500	—	10	193	239	47	2	56.67

Table 18. Age composition of spring and autumn spawners in north-eastern North Sea in April and May, 1957

Spring group						Autumn group						Total sample			
		April		May				April		May		No.		%	
Year-class	Winter-rings	No.	%	No.	%	Year-class	Winter-rings	No.	%	No.	%	Spring	Autumn	Spring	Autumn
1955	2	2	0.5	3	1.9	1954	2	7	1.3	7	2.1	5	14	26.3	73.7
1954	3	75	19.8	34	21.8	1953	3	55	10.5	57	16.7	109	112	49.3	50.7
1953	4	94	24.9	39	25.0	1952	4	168	31.9	142	41.5	133	310	30.0	70.0
1952	5	75	19.8	33	21.2	1951	5	71	13.5	47	13.7	108	118	47.8	52.2
1951	6	102	27.0	38	24.4	1950	6	62	11.8	23	6.7	140	85	62.2	37.8
1950	7	27	7.1	6	3.9	1949	7	43	8.2	20	5.9	33	63	34.4	65.6
1949	8	2	0.5	2	1.3	1948	8	26	4.9	6	1.8	4	32	11.1	88.9
1948	9	1	0.3	—	—	1947	9	26	4.9	15	4.4	1	41	2.4	97.6
1947	10	—	—	1	0.6	1946	10	17	3.2	5	1.5	1	22	4.3	95.7
1946 and older	>10	—	—	—	—	1945 and older	>10	51	9.7	20	5.9	—	71	—	100.0
Total number of otoliths examined ..		378		156				526		342		534	868	38.1	61.9

Table 19. Maturity and racial characters — North-western North Sea, 1957

	A. Percentage Maturity (All age-groups) Maturity stage								B. Vert. S. (Actual numbers — all age-groups) Number of vertebrae							
	I	II	III	IV	V	VI	VII	VII-II	No.	54	55	56	57	58	59	Mean
Aberdeen																
May	14.3	**39.5**	0.2	0.2	—	0.2	3.9	**41.8**	545		12	227	251	39	—	56.60
June	16.4	**47.4**	17.7	3.5	1.5	—	1.1	12.4	892	2	20	332	404	51	1	56.60
July	12.4	**31.1**	**33.0**	13.9	8.4	—	0.1	1.2	1,050	—	28	407	471	44	2	56.56
August	0.2	3.6	18.7	19.4	**24.1**	16.0	10.5	7.4	998	—	24	438	461	47	2	56.55
Sept.	—	—	7.4	7.4	3.2	17.4	**42.6**	22.1	190	—	9	79	87	9	—	56.52
Fraserburgh																
May	**41.0**	**36.8**	0.6	—	0.2	—	1.0	20.4	495	—	10	116	146	14	1	56.58
June	**36.8**	**49.7**	8.6	1.5	0.5	—	0.1	2.8	791	1	7	98	112	18	1	56.60
July	8.8	**36.3**	**32.3**	15.6	6.2	—	0.3	0.7	1,074	—	17	226	246	25	1	56.55
August	2.3	6.9	**22.2**	15.2	**24.8**	13.0	10.6	5.0	941	—	15	229	234	19	2	56.53
Sept.	—	0.4	12.7	10.7	6.6	**23.0**	**21.7**	**25.0**	244	—	1	24	21	2	—	56.50
Peterhead																
May	**60.7**	28.1	0.7	—	0.2	—	0.7	0.7	445	—	6	93	118	20	—	56.64
June	**40.7**	**48.4**	5.8	1.5	0.2	—	—	3.5	1,042	—	20	233	246	27	1	56.54
July	12.8	**32.4**	**27.7**	18.3	7.8	0.1	0.1	0.9	1,020	1	17	173	178	10	1	56.48
August	2.2	9.1	**19.2**	13.8	**22.0**	9.4	12.0	12.3	926	—	14	194	190	20	1	56.52
Sept.	0.4	1.2	4.1	6.5	3.6	16.2	**32.4**	**35.6**	247	—	8	78	98	8	—	56.55
Lerwick																
May	2.7	**24.6**	0.7	—	0.1	0.4	**23.8**	**47.8**	1,086	—	18	391	558	89	1	56.68
June	11.2	**47.0**	18.9	5.7	1.9	—	2.4	12.9	1,040	1	28	423	497	63	2	56.59
July	2.5	15.0	**32.1**	24.9	16.0	0.6	0.7	8.2	1,084	1	28	402	515	62	2	56.61
August	0.8	10.3	**20.7**	15.3	**32.2**	4.6	13.2	2.9	242	—	5	110	105	12	1	56.55

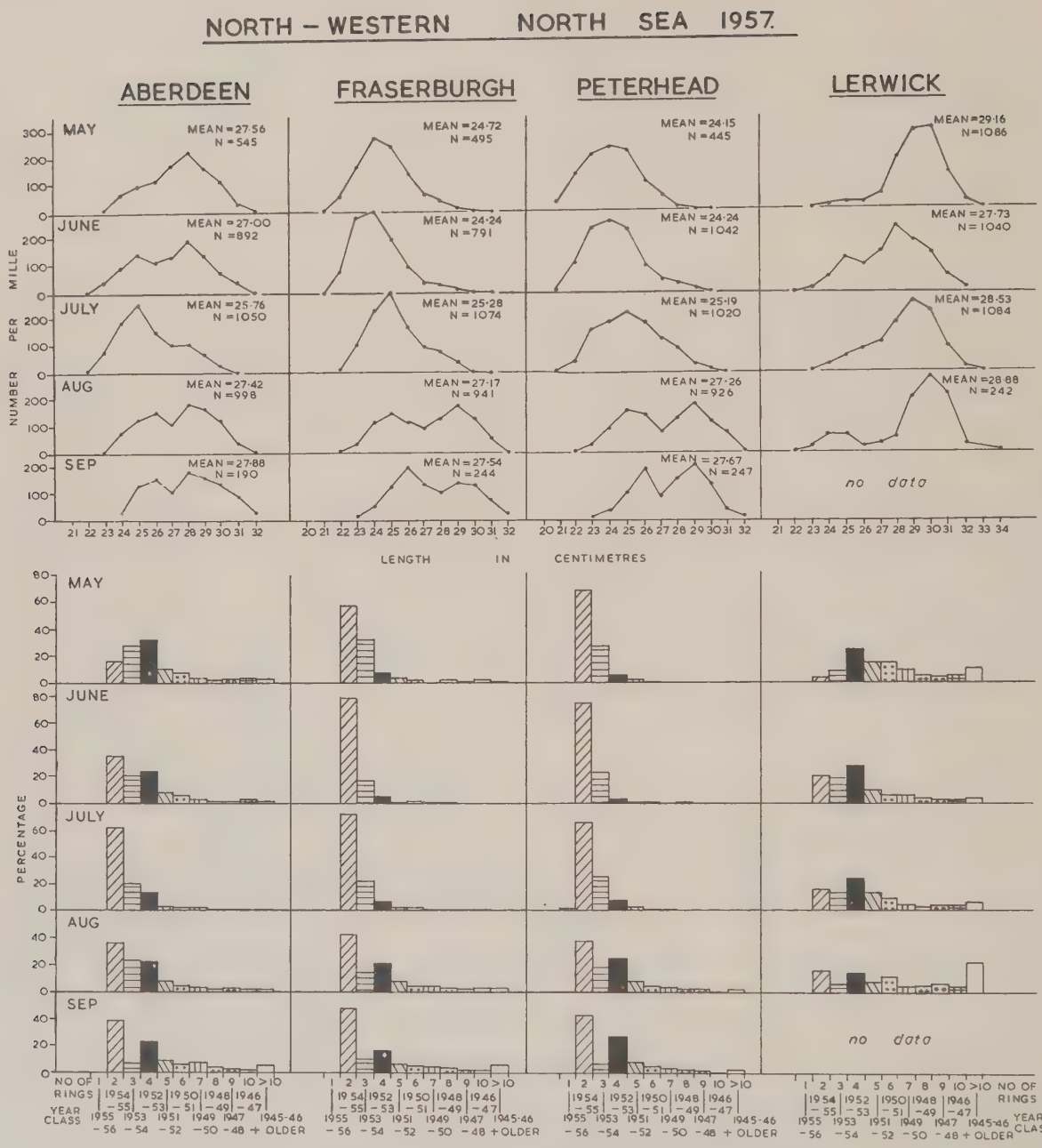

NORTH – WESTERN NORTH SEA 1957.
ABERDEEN
FRASERBURGH
PETERHEAD
LERWICK
MAY
JUNE
JULY
AUG
SEP
MEAN = 27·56 N = 545
MEAN = 24·72 N = 495
MEAN = 24·15 N = 445
MEAN = 29·16 N = 1086
MEAN = 27·00 N = 892
MEAN = 24·24 N = 791
MEAN = 24·24 N = 1042
MEAN = 27·73 N = 1040
MEAN = 25·76 N = 1050
MEAN = 25·28 N = 1074
MEAN = 25·19 N = 1020
MEAN = 28·53 N = 1084
MEAN = 27·42 N = 998
MEAN = 27·17 N = 941
MEAN = 27·26 N = 926
MEAN = 28·88 N = 242
MEAN = 27·88 N = 190
MEAN = 27·54 N = 244
MEAN = 27·67 N = 247
no data
NUMBER PER MILLE
LENGTH IN CENTIMETRES
PERCENTAGE
NO OF RINGS
YEAR CLASS
1955 1953 1951 1949 1947 1945-46
– 56 – 54 – 52 – 50 – 48 + OLDER

Figure 10. Length and age compositions of north-western North Sea drift-net samples May—September 1957. (Length frequencies unsmoothed).

During the pre-spawning fishery in May—June and July the stock on the Buchan grounds (Aberdeen, July, and Fraserburgh and Peterhead, May to July) were characterized by the dominance of 3-year-olds (2-ringers) which made up 70% of the samples. On the northerly grounds (Lerwick, May to August, and Aberdeen, May and June) herring of all age-groups were present, with 4-ringers most prominent and 2-ringers forming less than 20% of the samples.

The length and age composition of the May catches from the northerly grounds are very like the length and age composition of the catches in the north-eastern North Sea. Further evidence to

support the view that the main recruitment to the Shetland fishery comes from the east is found in the analysis of otolith characters of the Shetland samples between May and July, given in Table 20. As in the north-eastern North Sea the catches at Shetland consist of a mixture of spring spawners mostly showing 3 to 6 winter-rings and of autumn spawners of all ages with 4-ringers the dominant age-group.

Four-ringers are more evident in the Aberdeen than in the Fraserburgh-Peterhead samples in June and July and become prominent in the samples from the spawning fishery in August. This supports the view that a large part of the spawning shoals on the Scottish east coast is derived from pre-spawning concentrations further to the north and east.

The mean lengths for age calculated for the Fraserburgh-Peterhead samples show that the high values recorded in previous years were maintained in 1957. The values for age-groups II to V for the years 1954—1957 were as follows:—

Age (winter-rings)	Mean lengths (cm.) 1954	1955	1956	1957
2	24.69	24.18	24.76	24.28
3	26.92	26.81	26.97	26.16
4	28.12	28.68	28.36	28.30
5	28.71	29.34	29.43	29.31

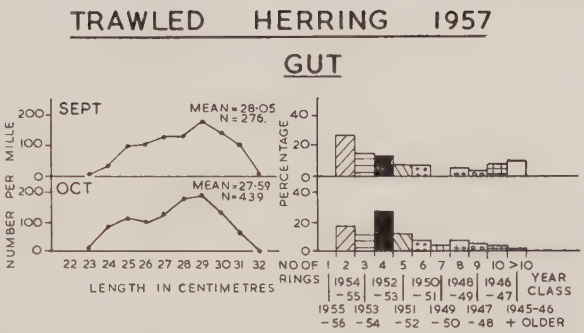


Figure 11. Length and age composition of trawl samples September—October 1957.
(Length frequencies unsmoothed).

Gut

Samples were taken during September and October 1957 from the landings by Swedish trawlers from the Gut. The length and age composition of these samples are shown in Figure 11 and the maturity and Vert. S. data are given in Table 21.

These data suggest that the herring caught in the Gut belonged to the same stock as the spawning shoals on the Scottish east coast in August—September.

No samples were obtained from the Fladen Ground.

Table 20. Age composition of spring and autumn spawners at Shetland in May—July, 1957

		Spring group							Autumn group							Total sample	
		May		June		July				May		June		July		Spring	Autumn
Year-class	Winter-rings	No.	%	No.	%	No.	%	Year-class	Winter-rings	No.	%	No.	%	No.	%	%	
1955	2	1	0.5	8	6.3	10	7.1	1954	2	28	3.4	205	22.6	169	18.1	4.5	95.5
1954	3	31	14.7	38	29.9	40	28.4	1953	3	64	7.8	163	18.0	103	11.0	24.8	75.2
1953	4	51	24.2	31	24.4	24	17.0	1952	4	196	24.0	264	29.1	242	25.9	13.1	86.9
1952	5	41	19.4	23	18.1	28	19.9	1951	5	106	13.0	81	8.9	113	12.1	23.5	76.5
1951	6	67	31.8	19	15.0	31	22.0	1950	6	88	10.8	39	4.3	76	8.2	36.6	63.4
1950	7	15	7.1	8	6.3	5	3.6	1949	7	88	10.8	53	5.9	50	5.4	12.8	87.2
1949	8	2	1.0	—	—	1	0.7	1948	8	46	5.6	28	3.1	32	3.4	2.8	97.2
1948	9	—	—	—	—	1	0.7	1947	9	39	4.8	21	2.3	43	4.6	1.0	99.0
1947	10	2	1.0	—	—	1	0.7	1946	10	46	5.6	25	2.8	37	4.0	2.7	97.3
1946 and older	>10	1	0.5	—	—	—	—	1945 and older	>10	116	14.2	27	3.0	68	7.3	0.5	99.5
Total number of otoliths examined		211		127		141				817		906		933		15.3	84.7

Table 21. Maturity and racial characters — Gut, 1957

	A. Percentage maturity (All age-groups) Maturity stage									B. Vert. S. (Actual numbers — all age-groups) Number of vertebrae						
	I	II	III	IV	V	VI	VII	VII-II	No.	54	55	56	57	58	59	Mean
September	2.2	1.8	6.2	6.9	7.6	15.9	25.4	34.1	276	—	7	113	131	18	1	56.60
October	0.9	2.1	8.7	7.7	2.3	5.5	25.3	47.6	439	—	11	191	212	15	—	56.54

Table 22. West coast herring landings 1954—1957

	North Minch			South Minch		
	Landings (crans)	No. of arrivals	Landings per arrival (crans)	Landings (crans)	No. of arrivals	Landings per arrival (crans)
			Drift-net			
1954	183,951	7,928	23.2	17,128	455	37.6
1955	79,557	4,710	16.9	21,605	633	34.1
1956	80,727	4,423	18.3	39,010	971	40.2
1957	114,561	5,285	21.68	11,005	318	34.61
			Ring-net			
1954	37,488	1,142	32.8	68,629	1,568	43.1
1955	34,781	875	39.7	55,241	1,201	46.0
1956	21,762	774	28.1	50,782	1,125	45.2
1957	20,652	881	23.44	43,466	1,563	27.81

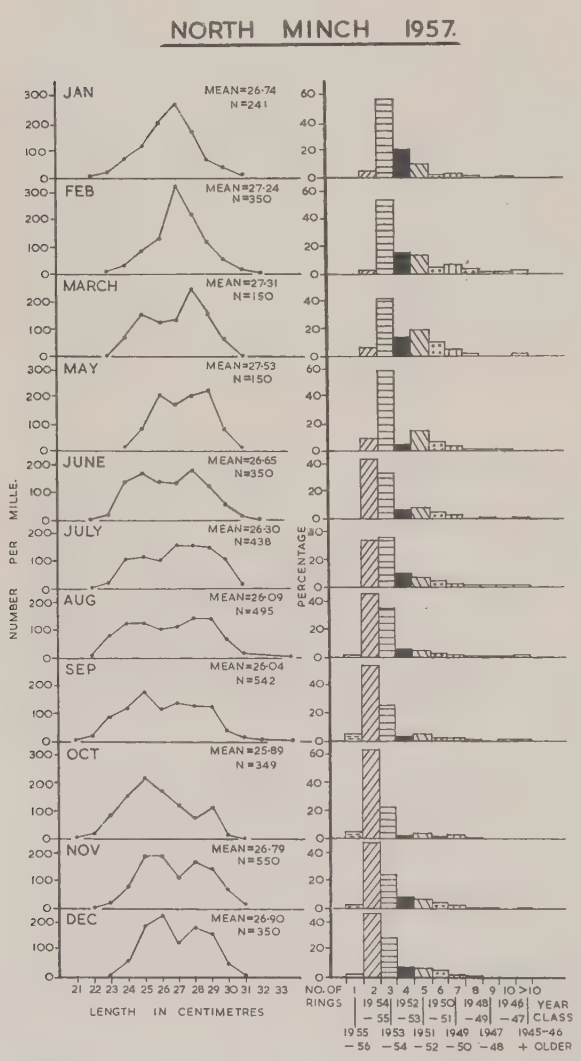


Figure 12. Length and age composition of North Minch drift-net samples January—December 1957. (Length frequencies unsmoothed).

B. West Coast

Minch

Herring fishing in the Minch in 1957 followed the same general pattern as in previous years. Catches, obtained by drift-net and ring-net, were landed at the following ports: Stornoway, Ullapool, and Gairloch in the North Minch and Mallaig and Oban in the South Minch.

In the North Minch, the drift-net fishery for recovering autumn spents and maturing spring spawners in January and February was conducted with fair success but in the South Minch during the same period catches were lower than in previous years. The difference in the degree of success between the North and South Minch catches was due to the fact that maturing spring spawners were much more abundant in the North.

The spring fishery for spawning herring along the north-west mainland coast continues to yield very poor catches.

During the summer, the drift-net and ring-net fisheries were less productive than in 1956. This was due to some extent to the fact that adolescent spring spawners were far less abundant compared with the previous year.

Large shoals of recovering autumn spents appeared in the Minch in the late autumn which led to a considerable improvement in the catches during this period.

The landing statistics for the North and South Minch are given in Table 22. These statistics show that the drift-net landings and catch per landing from the North Minch were higher than in 1956 but the drift-net and ring-net landings from the South Minch were lower than in the previous year. Length and age composition data from the North and South Minch are given in Figures 12 and 13 and maturities and Vert. S. are presented in Tables 23 and 24.

Table 23. Maturity and racial characters — North Minch — 1957

A. Percentage maturity (all age-groups)

Maturity stage	Jan.	Feb.	Mar.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
I	8.71	4.29	11.33	17.33	26.29	16.06	13.33	**26.57**	**35.82**	15.09	13.71
II	13.28	4.00	4.67	5.33	**56.29**	**36.24**	**27.47**	19.00	10.60	4.18	2.57
III	19.09	**26.57**	4.67	—	9.43	17.20	18.99	8.12	6.30	11.82	6.86
IV	5.93	14.00	6.67	—	2.57	11.70	**27.88**	6.09	2.29	5.82	7.14
V	—	0.57	—	—	0.29	13.07	5.66	2.21	—	0.36	2.00
VI	—	—	2.00	—	—	0.23	—	1.29	—	0.18	—
VII & VII–II ..	**53.53**	**50.57**	**70.67**	**77.34**	5.14	5.50	6.67	**36.72**	**44.99**	**62.55**	**67.72**
Number	241	350	150	150	350	436	495	542	349	550	350

B. Mean Vert. S. for each maturity stage (all age-groups)
(Nos. in brackets are numbers of fish)

I	56.71	56.79	56.63	56.85	56.96	56.97	56.75	56.77	56.69	56.69	56.72
	(21)	(14)	(16)	(26)	(90)	(66)	(65)	(139)	(123)	(83)	(47)
II	56.90	56.79	56.71	56.50	56.57	56.68	56.87	56.96	56.97	57.04	56.78
	(31)	(14)	(7)	(8)	(196)	(143)	(134)	(102)	(35)	(23)	(9)
III	56.91	56.99	56.71	—	56.42	56.52	56.58	56.74	56.95	56.88	57.08
	(45)	(90)	(7)		(33)	(73)	(92)	(42)	(21)	(65)	(24)
IV	57.08	57.02	57.10	—	56.50	56.63	56.46	56.61	57.38	57.03	56.88
	(13)	(49)	(10)		(8)	(38)	(137)	(31)	(8)	(32)	(25)
V	—	57.00	—	—	58.00	56.68	56.56	56.64	—	56.50	57.17
		(2)			(1)	(56)	(27)	(11)		(2)	(6)
VI	—	—	57.00	—	—	57.00	—	56.71	—	57.00	—
			(2)			(1)		(7)		(1)	
VII & VII–II ..	56.40	56.60	56.43	56.62	56.71	56.91	56.85	56.59	56.49	56.57	56.58
	(128)	(167)	(105)	(114)	(17)	(23)	(33)	(182)	(145)	(338)	(234)
Overall mean ..	56.63	56.79	56.53	56.66	56.66	56.71	56.67	56.73	56.67	56.67	56.67

Table 24. Maturity and racial characters – South Minch – 1957

A. Percentage maturity (all age-groups)

Maturity stage	Feb.	Mar.	May	June	July	Oct.	Nov.
I	12.00	10.00	9.60	10.00	**26.00**	18.00	**20.00**
II	2.00	5.20	—	**75.33**	**32.00**	2.67	7.33
III	7.20	1.60	—	0.67	**34.00**	3.33	8.00
IV	1.20	1.20	—	0.67	5.33	3.33	6.00
V	0.40	—	—	—	2.00	0.67	1.33
VI	2.00	—	—	—	—	—	—
VII & VII–II	**75.20**	**82.00**	**90.40**	13.33	0.67	**72.00**	**57.34**
Number	250	250	250	150	150	150	150

B. Mean Vert. S. for each maturity stage (all age-groups)
(Nos. in brackets are numbers of fish)

I	56.66	56.80	56.75	56.93	56.84	56.89	56.73
	(29)	(25)	(24)	(15)	(38)	(27)	(30)
II	56.40	56.69	—	56.51	56.89	56.50	57.00
	(5)	(13)		(113)	(47)	(4)	(11)
III	56.78	57.25	—	57.00	56.42	56.80	56.83
	(18)	(4)		(1)	(50)	(5)	(12)
IV	57.00	56.67	—	57.00	56.63	57.20	57.22
	(3)	(3)		(1)	(8)	(5)	(9)
V	58.00	—	—	—	56.33	57.00	56.50
	(1)				(3)	(1)	(2)
VI	56.80	—	—	—	—	—	—
	(5)						
VII & VII–II	56.51	56.55	56.49	57.00	57.00	56.52	56.64
	(187)	(204)	(222)	(20)	(1)	(106)	(86)
Overall mean	56.56	56.60	56.51	56.63	56.69	56.62	56.73

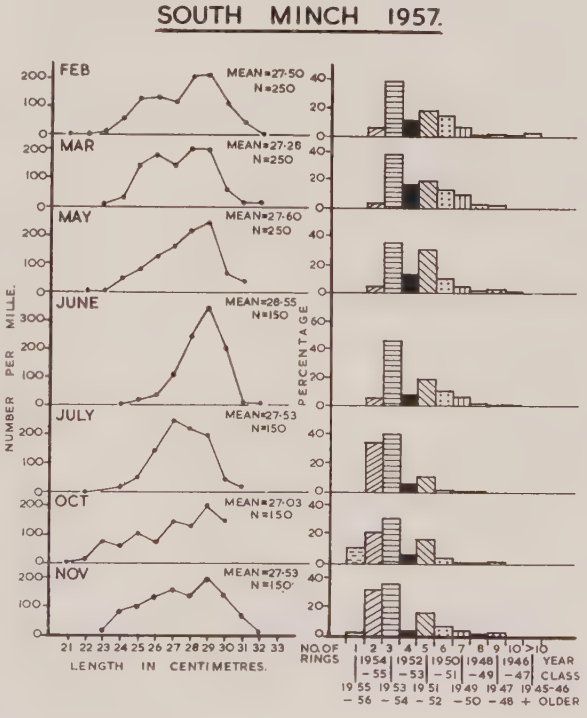


Figure 13. Length and age composition of South Minch drift-net (March) and ring-net (February and May—November) samples 1957. (Length frequencies unsmoothed).

The North Minch data are from drift-net, and the South Minch data are from ring-net except March when they are from drift-net.

The age composition data show that in the North Minch, 3-year olds (2-ringers), which were the new recruits to the stock, did not appear in abundance in the catches until June but with the exception of July predominated in the catches during the rest of the year. Racial analysis indicated that these new recruits were mainly autumn spawners. In the South Minch 4-year olds (3-ringers) of the 1953—54 brood predominated in the catches throughout the year. Three-year olds, which began to appear in abundance in July were less abundant in the catches than in the North Minch. Racial data showed that these fish were mainly autumn spawners. In the South Minch 6-year olds of the 1951—52 brood were fairly prominent in the catches during most of the year.

Table 25. Scottish herring tagging liberations 1957

Area	Period	Type and number		
Upper Moray Firth (Halflin stock)	Feb.	Lea	1000	3428
		Scottish	2428	
	Dec.	Scottish		800
North-eastern North Sea	May–June	Scottish		1015
Shetland	May	Scottish		400
	July	Scottish		735
Bløden	Aug.	Scottish		1396
Channel	Nov.	Scottish		697
North Minch	Jan.	Lea	30	230
		Scottish	200	
	Nov.–Dec.	Lea	500	1540
		Scottish	1040	
Total		Lea	1530	10,241
		Scottish	8711	

C. Tagging

In 1957 tagging was carried out both on commercial vessels and on research vessels using Lea and Scottish combination tags attached by toggles and Scottish one-man bridles. Scottish scientists on board F.R.S. "Clupea" co-operated in the international herring tagging programme on the Bløden Ground in August 1957 and released 1,396 Scottish tags. A Scottish scientist also co-operated in the French tagging experiment in the Channel during November 1957 and 697 Scottish tags were liberated there. The results of these experiments are not recorded here.

Details of the liberations and recaptures are given in Tables 25 and 26.

The general pattern of the returns from the northern North Sea liberations is the same as in previous years. An interesting record is of the

Table 26. Scottish herring tagging recaptures 1957
(Numbers in brackets are days at liberty)

Liberation		Area of recapture	Lea	Scottish
Upper Moray Firth	February	Upper Moray Firth	2 (1–4)	4 (6–13)
		Percentage of liberations	0.2	0.2
	December	Upper Moray Firth	—	1 (35)
		Percentage of liberations	—	0.1
North-eastern North Sea		Fladen	—	14 (1–91)
		English north-east coast	—	1 (100)
		Dogger Bank	—	1 (118)
		Utsira Hole	—	1 (189)
		Unknown	—	1
		Total	—	18
		Percentage of liberations	—	1.8
Shetland	May	North of The Patch	—	1 (51)
		Fladen	—	13 (27–80)
		Dogger Bank	—	1 (76)
		English Channel	—	1 (175)
		Skagerak	—	1 (234)
		Unknown	—	5
		Total	—	22
		Percentage of liberations	—	5.5
	July	Fladen	—	2 (10–13)
		Percentage of liberations	—	0.3
North Minch	January	North Minch	—	2 (48–52)
		Percentage of liberations	—	0.9
	November—December	North Minch	1 (16)	2 (0–66)
		South Minch	5 (12–83)	—
		Unknown	—	1
		Total	6	3
		Percentage of liberations	1.2	0.3

herring which was tagged off Shetland on 30. May 1957 and recaptured by a trawler between Calais and Dieppe during November 1957. The herring was at maturity stage III when recaptured. Another herring from the same tagging was recaptured on the Dogger Bank during August 1957.

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Survey of the German Commercial Herring Fisheries and the Biological Conditions of the Stocks

(Tables 27–32)

A. The Fishery

The total herring landings from the German fishing fleet are recorded in Table 27.

Table 27. Total herring landings (in 1000 tons) of the German fishing fleet in 1957

	North Sea	Channel	Other areas	Total
Trawlers	**128** (123)	**19** (19)	1 [1](—)	**148** (142)
Drifters	**67** (56)	**6** (7)	— (—)	**73** (63)
Drift-net	46 (44)	6 (6)	— (—)	52 (50)
Trawl	21 (12)	+ (1)	— (—)	21 (13)
Deep-sea cutters	**23** (26)	+ (+)	**17** (23)	**40** (49)
Herring trawl fishery				
(for consumpt.)	2 (1)	+ (+)	15 [2](21)	17 (22)
(for factories)	21 (25)	— (—)	2 [3](2)	23 (27)
Total	218 (205)	25 (26)	18 (23)	261 (254)

( ) = 1956
[1]) South-east coast of Ireland.
[2]) Baltic/Kattegat/Skagerak.
[3]) Baltic/Kattegat.

The total catch increased by 2.8%. 91.2% (238,000 tons) consisted of herring for human consumption, 8.8% of factory herring (23,000 tons). The surplus resulted from the North Sea catch, while in the other areas the catches decreased. The catch in the North Sea of herring for consumption rose by 17,000 tons, while the factory herrings decreased by 4,000 tons.

1. Herring trawlers

The catch of the trawlers in the North Sea increased by 4,428 tons (3.6%), while the number of trips fell off from 1,251 to 1,174 (6.6%). The catch per day's fishing (12.7 tons) was 1.6 tons greater than in 1956 (11.1 tons).

(a) The spring fishery was concentrated on the Viking Bank, in the Utsira Region ("Ostkante") from January to June. Some fishing was also operated in the Shetland area. The total landings of this season amounted to 10,018 tons (+ 42.1%). 230 trips were made as compared with 168 in 1956. The catch per day's fishing was the same as in the previous year (3.3 tons). The increased yield was the result of increased effort.

To the Viking Bank 191 trips (135 in 1956) and to Utsira 27 (16 in 1956) were made. 8,992 tons were caught on the Viking Bank and 857 tons at Utsira. The catch decreased from 5.4 to 4.2 tons in the Viking Bank area and rose slightly, from 3.7 to 4.0 tons, at Utsira.

(b) The summer/autumn fishery started on the Fladen Ground area about 20. June and was carried on for 82 days. From 9.—31. October some boats were fishing once more in this area. The trawlers made 596 trips (1956 = 609) and the total yield increased from 70,587 to 76,023 tons (+7.7%). Also the catch per day's fishing increased from 13.4 to 15.5 tons.

The fishery on the Gut took place from the middle of August till the end of October and lasted for 53 days. 43 trips were made (1956 = 69). The total yield dropped from 6,437 to 5,176 tons as the result of reduced effort. The catch per day's fishing increased, however, from 12.4 to 13.9 tons.

In the Dogger Bank area fishing commenced in mid-August and was continued for 72 days (1956 = 81) until the end of October. The number of trips declined from 321 to 237. As the result of reduced effort the total yield decreased slightly, from 34,878 to 32,641 tons. The catch per day, however, showed a considerable rise from 12.1 to 17.7 tons.

The yield of the German herring trawl fishery on the customary fishing places in the summer/autumn fishery showed a small increase from 111,902 to 113,840 tons.

(c) In the Channel fishery in November/December 231 trips were made against 189 in 1956. The total yield decreased from 18,728 to 17,563 tons. The catch per day's fishing showed also a decline from 11.3 to 9.5 tons.

The catch in November was taken in the Sandettié area. 6,800 tons against 6,709 in 1956 were caught. The catch per day was 7.6 against 9.8 tons.

In December the bulk of the catches came from Dieppe/Fécamp (9,661 tons against 11,341). The catch per day's fishing decreased from 15.2 to 8.8 tons.

Seven trips were made in December to Eddystone.

In January 1957 fishery was also operated in this area. 17 trips against 7 were made, and 657 tons landed. 575 tons came from Dieppe, 82 tons from Eddystone.

As the result of the reduced yields on the southern fishing grounds the trawlers started a fishery in October on the Viking Bank and at Utsira. As a

result of the reduced effort the catch decreased from 4,139 tons to 3,789. The bulk of the catch this year was taken in October. But also in November there was some fishing. The catch per day's fishing increased from 4.4 to 5.6 tons.

In December a number of trawlers were fishing for the first time on the south-east coast of Ireland. On 4 trips they caught 907 tons herring. The catch per day's fishing was 32.6 tons.

2. Drifters

From the end of February to June 1957 a part of the German drifter fleet operated in the northern North Sea (Viking Bank/Utsira) in order to market fresh herring.

219 trips against 185 in 1956 were made. The total yield increased from 7,899 tons to 9,287 (+ 17.6%). 6,628 tons were fished with drift-nets (71.4% of the total catch), and with trawl 2,659 tons (28.6%). The catch per day's fishing was 4.6 tons for the drift-net, 2.5 tons for the trawl.

The main fishing area was from February to May on the "Ostkante" between 59°—60°30′ N. Later the fishing shifted to the west. The increased yield was the result of increased effort.

From the North Sea 57,498 tons (+ 22.3%) against 47,025 in 1956 of salted herring were landed. The number of trips increased from 548 to 582 and only 31.7% of these herring were caught by trawl. The catch per day increased from 3.6 to 4.4 tons (drift-net) and from 4.1 to 5.9 tons (trawl).

On the Fladen Ground the total yield increased from 7,906 to 18,785 tons (+ 137.6%). 13,245 tons were caught with the trawl, 5,540 tons with the drift-net. The increased yield is mainly the result of increased effort. However, the catch per day showed also an increase from 2.5 to 3.6 tons for the drift-net and from 5.0 to 5.8 tons for the trawl.

On the Gut the catch dropped from 11,371 to 8,591 tons by a diminished drift-net fishery. The catch per day's fishing was 3.7 tons (1956 = 3.9) for the drifters, 5.4 tons (1956 = 4.7) for the trawlers.

In the Dogger Bank area the yield decreased from 17,430 tons to 14,406 as a result of reduced drift-net fishing. The catch per day increased from 3.7 to 4.6 tons (drift-net) and from 4.2 to 4.5 tons (trawl).

Fishing in the Southern Bight ("Binnensee") showed an increase from 8,198 tons to 10,734 (+ 30.9%). The number of fishing days increased from 1,823 to 2,058, the catch per day's fishing from 4.3 to 5.4 tons.

In the Channel the number of fishing days increased from 2,194 to 2,329. The total catch decreased from 6,853 to 6,595 tons. The catch per day fell off from 3.7 to 3.2 tons (drift-net) and increased slightly, from 3.5 to 3.8 tons for the trawl.

3. Cutters

The total yield of herring from the deep-sea and coastal cutters in the North Sea increased from 750 to 2,424 tons. Only 15 trips against 37 were made by the deep-sea cutters for herring for human consumption. The total output fell from 290 to 178 tons, the catch per trip increased from 7.8 to 11.9 tons.

The total yield of the herring fishery for oil production decreased further by 29.4% and fell from 24,209 to 17,087 tons, the total number of trips being 902, as against 1,233.

B. The Herring Stock

Fifty-four samples comprising 21,059 herrings were investigated and the main results are given in Tables 28—32.

1. Viking Bank/Utsira

In this area 17 samples were examined from January to May and in October and December. The average sizes of the herring in this area in the spring months were 29.38 to 33.62 cm.; in the autumn they were 28.24—30.69 cm. (Table 28). It appears from Table 29 that maturity stages VII/II and V were predominant in January, whereas stages V, VI, VII were most frequent in March, and stages VII and II in May. In October fish in stages III and II were abundant. The age composition of the catches (Table 30) indicates that in January the 2, 4, and over 10-year-old fish were predominant (595‰), in March, however, the 7 and over 10-year-old fish predominated (750‰). In the catches in October the 5—7 year-old fish were most abundant (778‰). The total number of vertebrae (V.S.) is given in Table 31 showing the average number of 56.66, 57.12, 56.82 in the spring months and 56.85 in October. The average number in relation to maturity stages in January gives a higher value (57.04) for stages IV—VI (Table 32) indicating that this group consisted of Atlantic late winter spawners, while the maturity stages VII and VII/II (56.46—56.47) were formed by autumn spawners. In March the Atlantic late winter spawners were predominating (IV—VI, VII, VII/II). In May the catches consisted of a mixture of different stocks. The bulk was North Sea or Skagerak late winter spawners, together with some Atlantic late winter spawners and North Sea autumn spawners. Also in October the catches were a mixture of these different stocks, but the late winter spawners were predominating.

Table 28. Length composition of all samples (‰) (Trawl)

Area	Viking Bank/Utsira								
Samples	Sea	Market	Market	Sea	Market	Market	Market	Market	Market
Month	I	I	II	III	III	IV	V	X	XII
cm. 38	—	—	—	8	2	—	—	—	—
37	—	—	11	29	15	—	1	—	—
36	—	—	18	120	36	2	2	—	—
35	—	—	14	169	49	4	4	—	3
34	—	—	21	98	26	2	6	—	—
33	2	3	14	**176**	48	11	18	—	—
32	25	38	79	166	112	45	56	30	—
31	100	135	136	126	143	94	97	90	32
30	**277**	301	**201**	39	175	205	165	270	179
29	255	**317**	183	32	**189**	**252**	**223**	**350**	**211**
28	150	109	168	32	129	198	194	190	176
27	79	55	108	5	47	110	158	60	125
26	57	19	32	—	23	50	62	—	102
25	26	13	11	—	5	14	12	10	91
24	19	5	4	—	—	6	2	—	59
23	9	1	—	—	—	4	—	—	19
22	—	4	—	—	1	3	—	—	3
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	635	1004	279	388	1276	1129	993	100	374
Av. length, cm.	29.38	29.81	30.13	33.62	30.99	29.42	29.41	30.69	28.24
Males ‰	491	—	—	457	—	—	447	460	—

Area	Fladen Ground				Gut	Dogger Bank	Channel		East of Dogger Bank		
Samples	Market	Market	Market	Sea	Sea	Sea	Market	Market	Market	Market	Sea
Month	VI	VII	VIII	IX	IX	IX/X	XI	XII	VII	VIII	IX
cm. 38	—	—	—	—	—	—	—	—	—	—	—
37	—	—	—	—	—	—	—	—	—	—	—
36	—	—	—	—	—	—	—	—	—	—	—
35	—	—	—	—	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—	—	—	—	—
33	—	—	2	2	—	—	—	—	—	—	—
32	—	1	4	8	10	4	—	—	—	—	—
31	3	5	23	67	46	28	—	—	—	—	—
30	35	19	111	**139**	115	48	5	5	—	—	—
29	49	59	151	132	115	65	12	10	—	—	—
28	71	128	**176**	123	**130**	91	20	15	—	—	—
27	**116**	188	130	86	110	91	35	35	—	—	—
26	104	152	93	135	125	100	93	70	—	—	—
25	196	**165**	**144**	**163**	**172**	150	148	135	—	—	—
24	**250**	134	120	111	121	**197**	210	230	—	—	—
23	153	97	37	29	49	168	**309**	**320**	—	—	—
22	21	42	7	3	5	49	133	160	1	—	—
21	2	9	2	—	—	9	30	15	10	10	—
20	—	1	—	—	—	—	2	5	19	10	61
19	—	—	—	—	—	—	3	—	75	120	**91**
18	—	—	—	—	—	—	—	—	311	210	63
17	—	—	—	—	—	—	—	—	**427**	**370**	46
16	—	—	—	—	—	—	—	—	157	210	55
15	—	—	—	—	—	—	—	—	—	50	82
14	—	—	—	—	—	—	—	—	—	—	**123**
13	—	—	—	—	—	—	—	—	—	20	104
12	—	—	—	—	—	—	—	—	—	—	**170**
11	—	—	—	1	—	—	—	—	—	—	105
10	—	—	—	1	—	—	—	—	—	—	68
9	—	—	—	—	—	—	—	—	—	—	30
8	—	—	—	—	—	—	—	—	—	—	2
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	576	2756	568	2614	1029	2501	969	200	817	100	2771
Av. length, cm.	25.81	26.28	27.50	27.70	27.38	26.41	24.42	24.32	17.41	17.13	14.71
Males ‰	600	576	540	466	520	439	440	555	—	—	—

Table 29. Sexual maturity in all samples (‰) (Trawl)

Area	Viking Bank/Utsira				Fladen Ground				Gut	Dogger Bank	Channel		East of Dogger Bank		
Month	I	III	V	X	VI	VII	VIII	IX	IX	IX/X	XI	XII	VII	VIII	IX
Stages I	65	3	10	10	—	73	90	5	17	36	20	10	1000	1000	1000
II	94	3	345	380	200	158	105	368	177	231	40	—	—	—	—
III	21	5	15	440	390	338	185	141	23	73	7	—	—	—	—
IV	65	3	—	130	400	291	260	113	100	149	213	—	—	—	—
V	255	205	—	—	10	140	250	257	177	184	117	140	—	—	—
VI	6	313	5	—	—	—	—	2	10	68	600	835	—	—	—
VII	494	468	625	40	—	—	110	114	496	259	3	15	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	679	389	200	100	100	399	200	1102	300	2501	300	200	198	100	379

2. Fladen Ground

From this area 8 samples containing 6,514 herrings were investigated. The average length increased from 25.81 cm. in June to 27.70 cm. in September (Table 28). The maturity was advancing from June to September, in June stages II—IV were predominant, while in August stages IV and V were more frequent. Also stage VII appeared in this month. In September all stages were present on this ground, stages I and VI, however, with low frequencies (Table 29).

The age composition (Table 30) shows the predominance of the rich 1952 year-class (5 years old) in June (300‰) and August (202‰). In July appears also the year-class 1953 (292‰) and 1951 (338‰). In September the more than 10-year-old fish (1947), the 1953 year-class (171‰) and 1950 (149‰) were more frequent.

The average number of vertebrae found was 56.52—56.73 (Table 31). The vertebral average of maturity stage II was markedly higher (56.98) than for those of stages III—IV (56.43) in June. In July and August the vertebral average of the immature and stages II and III—IV were higher (56.59—56.82) than those of stages V—VII (56.44 to 56.54). In October, however, the average of all stages were higher (56.73—56.86) with the exception of stage VII/II (56.50).

3. Gut

Three samples from September containing 1,029 herrings were examined. The average length was 27.38 cm. (Table 28). Maturity stage VII was predominant (496‰), but stages II, V, and IV were also abundantly represented (Table 29). The year-class 1954 (387‰) and 1952 (204‰) predominated in the catches (Table 30). The average number of vertebrae was 56.60 (Table 31). The vertebral average of stages II, III—IV was higher (56.65—56.91) than the average of stages V—VII/II (56.55). The bulk of the catches were autumn spawners mixed with late winter spawners (Table 32).

4. Dogger Bank area

From this area 14 samples containing 2,501 fish were investigated in September/October. The average length was 26.41 cm. (Table 28). Maturity stages VII and II (490‰) were predominant (Table 29). The 3-year-old fish (1954 year-class) was predominant with 527‰ and next in abundance were the broods of 1953 (155‰) and 1952 (107‰) (Table 30). The average number of vertebrae was 56.49 (Table 31). Autumn spawners of the bank herring type were those in maturity stages V—VII, VII/II, and immatures (56.42—56.50), while stages II and III—IV were a mixture of the Bank and Downs groups.

5. The Channel

Five samples comprising 1,169 fish were investigated in November and December. Three came from the Sandettié area, 2 from Dieppe. The average lengths in each area were 24.42 cm. and 24.32 cm. (Table 28). Maturity stage VI was predominant in both places (600‰, 835‰) (Table 29). The most important year-classes were 1954 (648‰, 659‰) and 1953 (243‰, 246‰) (Table 30). The average number of vertebrae were 56.61 and 56.56 respectively (Table 31). The bulk of the catch in both months belonged to the Downs group (Table 32).

6. Young herring east of Dogger Bank

From July to September 7 samples with 3,688 fish were investigated. The average lengths in the different months were 17.41, 17.13, and 14.71 cm. (Table 28). All these herring were immature (Table 29). Age-group I was the most important component in the age composition in July and August, while in September the 0-group was predominant (715‰) (Table 30). The average number of vertebrae was 56.49—56.58 (Table 31). The stock was presumably a mixture of the central and southern North Sea groups, of which the group from the central North Sea was most abundant in July (Table 32).

Table 30. Age composition of all samples (‰) (Trawl)

Locality		Viking Bank/Utsira				Fladen Ground				Gut	Dogger Bank	Channel		East of Dogger Bank		
Month		I	III	V	X	VI	VII	VIII	IX	IX	IX/X	XI	XII	VII	VIII	IX
Year-class	Age															
1956	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	715
1955	2	**323**	6	—	13	—	—	—	—	—	56	17	10	983	1000	285
1954	3	88	—	60	26	29	8	**202**	96	**387**	**527**	**648**	**659**	17	—	—
1953	4	**124**	17	159	52	257	**292**	154	**171**	127	155	243	246	—	—	—
1952	5	91	46	**245**	**185**	**300**	227	**202**	106	**204**	107	41	25	—	—	—
1951	6	53	67	146	171	100	**338**	117	74	77	40	17	30	—	—	—
1950	7	74	**465**	**265**	**422**	129	54	129	**149**	39	19	17	10	—	—	—
1949	8	41	38	20	—	57	19	61	85	25	17	10	15	—	—	—
1948	9	35	47	26	26	57	30	43	74	49	12	—	—	—	—	—
1947	10	23	29	13	39	43	11	12	53	28	19	7	5	—	—	—
<1947>10		**148**	**285**	66	66	28	21	80	**192**	**64**	**48**	—	—	—	—	—
Total		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ..		806	344	151	76	70	370	163	94	284	1235	292	199	175	89	379

Table 31. Total number of vertebrae (V.S.) ‰

Area		Viking Bank/Utsira				Fladen Ground				Gut	Dogger Bank	Channel		East of Dogger Bank		
Month		I	III	V	X	VI	VII	VIII	IX	IX	IX/X	XI	XII	VII	VIII	IX
V.S.	59	4	10	5	—	—	3	—	10	10	1	4	—	—	—	5
	58	94	231	116	124	62	63	61	82	51	51	61	43	70	44	39
	57	487	631	586	598	438	505	465	547	483	445	520	513	444	556	462
	56	385	128	278	278	458	393	459	351	442	447	379	407	427	356	444
	55	29	—	15	—	42	36	15	10	14	51	32	37	49	33	50
	54	1	—	—	—	—	—	—	—	—	4	4	—	10	11	—
	53	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Total		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ..		1045	390	198	97	96	394	198	97	292	1380	279	187	184	90	383
Av. V.S. ..		56.66	57.12	56.82	56.85	56.52	56.60	56.57	56.73	56.60	56.49	56.61	56.56	56.49	56.58	56.51

Table 32. Total number of vertebrae (V.S.) in relation to stages of maturity

Area	Viking Bank/Utsira								Fladen Ground					
Month	I		III		V		X		VI		VII		VIII		IX	
Stages of Maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver
juv.	—		6	57.50	2	56.50	1	56.00	—		34	56.85	17	56.82	—	
II	62	56.61	1	58.00	68	56.81	36	56.64	16	56.98	69	56.78	21	56.71	9	56.78
III—IV	14	56.64	2	56.50	3	56.00	56	57.04	79	56.43	156	56.59	37	56.68	22	56.86
IV—VI	217	57.04	201	57.05	—		—		—		232	56.44	101	56.46	26	56.73
V—VI	—		—		1	57.00	—		—		—		—		—	
VII	132	56.47	164	57.20	46	56.89	—		—		—		—		20	56.80
VII—VII/II .	—		—		—		4	56.50	—		—		22	56.54	—	
VII/II	201	56.46	16	57.06	78	56.82	—		—		—		—		20	56.50
Total	626	56.68	390	57.12	198	56.82	97	56.85	95	56.52	491	56.56	198	56.57	97	56.73

Area	Gut		Dogger Bank		Channel				East of Dogger Bank					
Month	IX		IX/X		XI		XII		VII		VIII		IX	
Stages of Maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver
juv.	5	56.80	172	56.42	6	56.50	2	56.00	185	56.49	90	56.58	383	56.51
II	51	56.65	125	56.52	11	56.73	—		—		—		—	
III—IV	36	56.81	362	56.52	1	57.00	—		—		—		—	
IV—VI	—		—		260	56.61	—		—		—		—	
V—VI	56	56.55	380	56.50	—		182	56.57	—		—		—	
VII	—		163	56.45	—		—		—		—		—	
VII—VII/II .	144	56.55	—		—		3	56.33	—		—		—	
VII/II	—		178	56.46	1	56.00	—		—		—		—	
Total	292	56.60	1380	56.49	279	56.61	187	56.56	185	56.49	90	56.58	383	56.51

Prospects

In 1956 a decline in yield and in the catch per day's fishing occurred on all German trawl fishing grounds. In 1957 the yields on the "Ostkante", the Fladen Ground, and the catch per day's fishing increased on all the North Sea grounds. The increased yield on the "Ostkante" was the result of increased effort. On the other North Sea grounds the fishing effort was reduced. The rise in the yield on the Fladen Ground indicated a greater abundance of fish this year. Presumably the conditions of the Bank herring were also better in the Gut and in the Dogger area as the catch per day shows. Bad weather, however, hindered seriously the fishery there in September and October. In the Channel the yield decreased in spite of increased effort, but the catch per day also decreased. In the fishery for young herring east of the Dogger the yields declined, because the hydrographical situation changed. With the warmer bottom water from the south the 0-group was predominant in this area, while the I-group disappeared.

Our investigations on the Bank herring showed that a change occurred, which was conditioned after 2 years by the hydrographical situation. Round the Dogger spawning took place. In the two previous years spawning could only be observed on the south-western edge of the Dogger. Also the age composition on the Fladen Ground and on the Dogger showed a more normal representation. In 1957 it seems that no strong year-class (1954) appeared in the fishery. Since the war three strong year-classes have appeared in the fishery, viz., in 1949, the 1946-class, 1952, the 1949-class, and in 1955 the 1952 year-class. It is of great interest to see if this 3-year cycle of rich year-classes should repeat itself in 1958.

Judging from the relative frequency of the year-classes we may assume that the 4-year-old (1954), 5-year-old (1953), and 6-year-old herring (1952) will be plentiful, and perhaps the 7-year-old (1951) will also be more abundantly represented in the catches in the northern North Sea. With regard to the Dogger Bank area it is difficult to say anything definite at the moment. It will chiefly depend upon the recruit spawners (1955 year-class) and the hydrographic conditions. Unfortunately no investigations could be conducted in the spring of 1958.

K. Schubert

German Herring Tagging Experiments

During 1957 herring tagging was carried out in three different areas.

The first experiments were made on 25. and 26. January off Skagen between 57°36′N.—57°55′N. and 8°42′E. —9°37′E. on board the "Anton Dohrn". Only 134 trawl-caught herrings were tagged with the yellow plastic tag (DHb), fixed between the head and the dorsal fin by means of a bridle and pin of stainless steel. The lengths of the fish were measured but no scale-reading took place.

Up to 17. February 1958 5 herrings have been recaptured, that is 3.73%. All the recaptures have been made within a comparatively short distance from the place of liberation, W.N.W. and N.N.E. of Hirtshals. The last fish was caught on 8. July 1957, 164 days after liberation, whereas the average time elapsed between tagging and recapture was 74.6 days.

During the period 14. to 18. April 1957, 290 herrings were tagged in the estuary of the River Elbe at Cuxhaven and Otterndorf. The herring, spring spawners of the coastal type, were captured by stow-nets and a fyke-net with wings and tagged with the Lea hydrostatic tag. There were 11 recaptures, i.e., 3.79%; 10 of these have been made within the estuary, whereas one herring has been caught by a Swedish cutter in 57°50′N., 11°23′E. by drift-net on 12. June. The migration of one of the Elbe spring spawners to the Bohuslän coast shows at least the possibility of a connexion between the Elbe herring and the spring spawners of the Danish straits. The average days of freedom were calculated to be 33.6, the last herring was caught 70 days after liberation, on 17. June. Presumably the herring then left the Elbe estuary.

In the Dogger Bank area tagging has been carried out on 22. and 23. September and on 1. and 2. October from F.R.S. "Anton Dohrn". 1,631 trawl-caught herrings were liberated in the area between 55°10′N.—55°42′N. and 0°20′E.—2°42′E. Up to the present there are only 7 recaptures, i.e., 0.43%, all within the first week after liberation. In this experiment a bucket for liberating the tagged fish in deep water was used, constructed according to the container used by Danish and Swedish research workers.

The first results, as shown by the very small numbers of recaptures, are, however, not so encouraging, but the experiments will be continued in 1958.

G. Krefft

Table 33. Meristic characters, length, and age of spring spawners in the River Ems

Vert. S.	55.44 ± 0.052	1 winter-ring	n = 1	
n	220	2 winter-rings	n = 15	L = 21.4 cm.
Keeled scales (K_2)	13.45 ± 0.05	3 winter-rings	n = 47	L = 22.8 cm.
n	222	4 winter-rings	n = 4	
Length (L), cm.	22.43 ± 0.235	5 winter-rings	n = 2	
n	242			

Coastal Herring from the Ems Estuary

(Table 33)

Between the end of April and June 1957 full herring were caught by stow-nets on stakes in the north-eastern part of the Dollart (River Ems). Every year there is a small group of spring spawners immigrating into the Ems estuary. In comparison with the population in the Elbe estuary the herring in the River Ems seem to mature at an earlier age, e.g., at the end of their third or even second year of life. Moreover, their growth is faster. In connexion with Table 33 it may be mentioned that the sample was salted. Part of the fish were measured twice, before and after salting, and show a mean decrease in length of about 7 mm. The average length is derived from the uncorrected data for salted, ungutted herring. After salting only one-third of the otoliths was fit for age dermination, so the exact age composition of the sample is not known.

G. Hempel

Reference

Hempel, G., 1953: Mitt. Fischereibiol. Abt. Max-Planck-Inst. Meeresbiol., Wilhelmshaven, 3: 43–45.

The Herring Fisheries of the Netherlands in 1957

(Figure 14; Charts 13–40; Table 34)

Drift-net fisheries

As in former years the skippers of our drift-net vessels gave information about the area of fishing and the quantity of the catches. Of the total quantity of drift-net herring landed in 1957 approximately 60% could be incorporated in these detailed statistics. Charts 13—20 show the monthly distribution of the shots about which information was received, and Charts 21—28 present the mean catches per shot. A difference with former years is that the actual figures are now shown. In the *Statistical News Letters* for 1957 the total quantity of drift-net herring landed per statistical rectangle will be given, estimated by raising the "sample" shown here to the monthly total catches.

Fishing started on 21. May. From 21.—28. May 60 nets were shot, from 28. May up to 15. June 90 nets were used, and after 15. June the number of nets shot increased to 100 and remained so for the rest of the season.

In the period from May to July the main fishery has been carried out further north than in the year 1956. Everywhere catches were poor in this period. The August fishery, on the other hand, has been exceptionally good.

Fishery was rather poor in the Dogger Bank area. Catches were about the same as last year's.

The same holds for the East Anglian fishery. In this area the average catch per shot was slightly higher than in 1956.

Table 34 A gives the total quantity of drift-net herring landed. The herring landed in the period from January to May is not included in the charts. This herring has mainly been caught in the northern North Sea.

The total weight of herring landed by the drift-net fisheries in 1957 was 55,903 tons.

Trawl fisheries

In 1957 the method for collecting information concerning area of fishing and number of fishing hours in the trawl fishery has been changed and improved. Far more data became available now with the result that area and fishing intensity is known for 50% of the total quantity of trawled herring landed in 1957.

Detailed statistics of these data are shown in Charts 29—40. The data are presented in figures and not by different shadings as in former years. The upper figure shows the catch in tons per 100 hours' fishing, the lower figure the effort expressed in 100 hours of fishing. In these charts no attempt has been made to weigh the total quantity of trawled herring landed. This will be done for the *Statistical News Letters*, based on the sample shown here.

One important feature of the charts must still be mentioned. With the method worked out by Gulland (1956) correction factors for motor-power have been computed for herring trawling for all types of vessels. In this way all fishing intensity could be transformed to the fishery of a standard ship. The fishing hours presented in the charts are not the actual fishing hours, but are expressed in fishing hours of a standard motor trawler of 500 B.H.P.

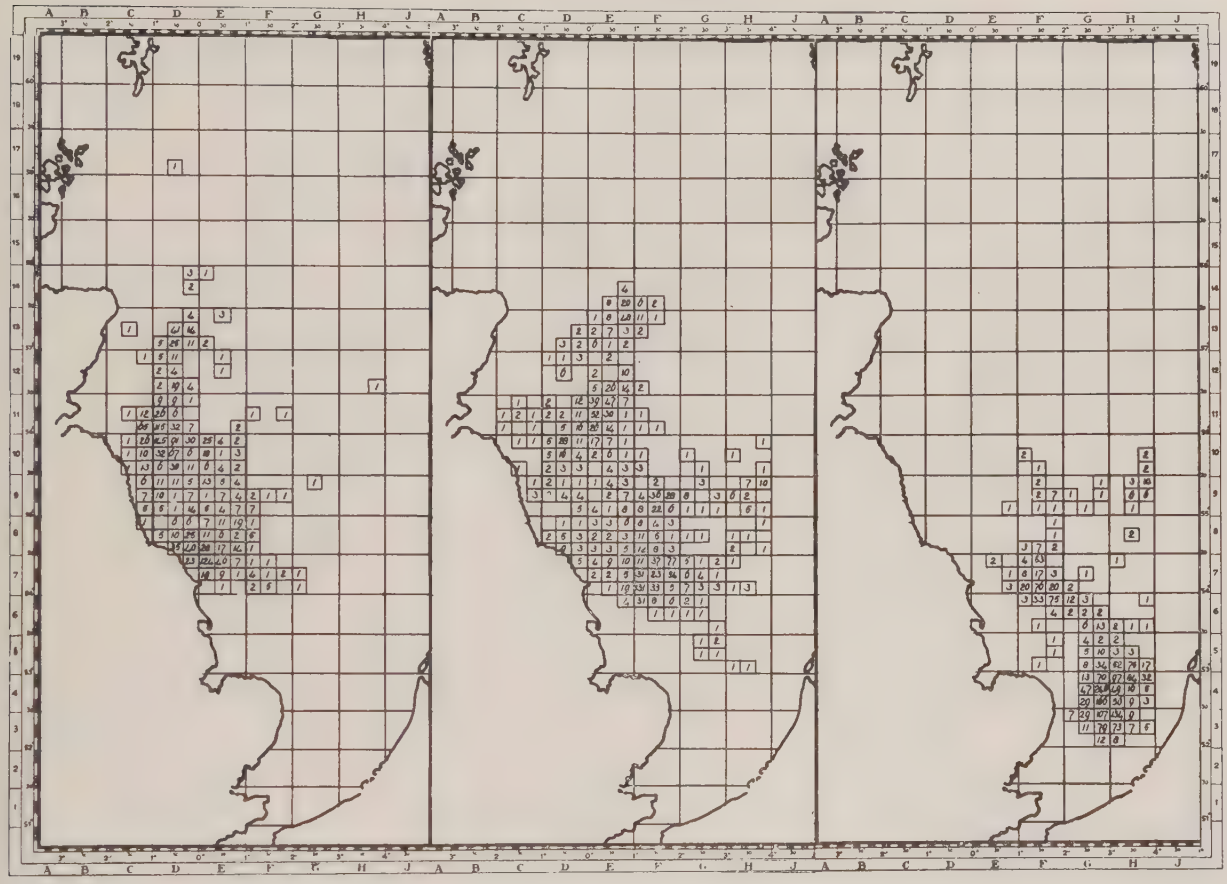
Number of Shots

Charts 13–15. May June July

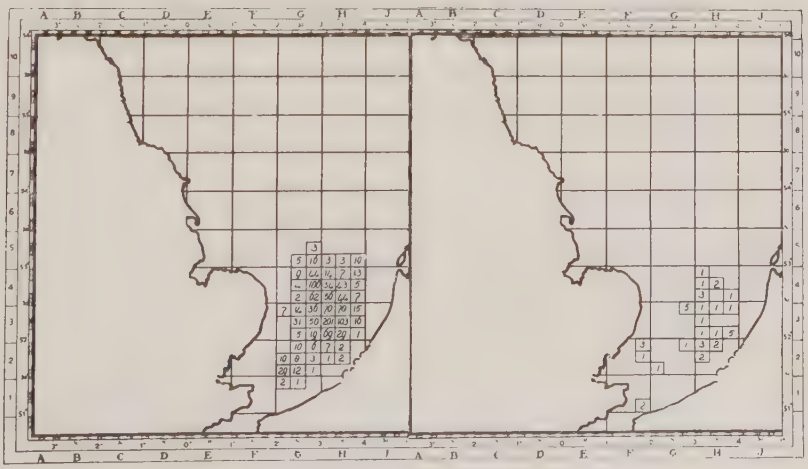
Table 34. Quantities of herring landed in Dutch ports in 1957

Month	A. Landed by luggers fishing with drift-nets					B. Trawled herring (in tons)	
	Salted herring (in kantjes) Gutted				Fresh herring (in kg.)	Trawlers and luggers	All kinds of vessels
	Matjes	Full	Spent	Ungutted			
January	—	3	—	1,241	64,250	394	827
February	—	—	—	2,407	148,700	806	904
March	—	—	—	1,035	180,212	975	1,046
April	—	—	—	623	275,106	916	916
May	3,594	—	—	7	113,180	674	674
June	34,931	—	—	2,047	495,290	1,090	1,090
July	48,743	2,073	27	13,839	146,060	5,804	5,804
August	17,042	41,450	3,236	44,276	240,743	10,949	10,965
September	2,949	25,125	11,089	21,264	33,650	12,390	12,459
October	21	24,653	2,161	104,842	1,629,381	5,052	5,061
November	—	1,173	14	102,901	2,246,533	2,107	2,526
December	—	544	63	37,098	352,510	2,190	2,473
Total 1957	107,280	95,021	16,590	331,580	5,931,615	43,347	44,745

Number of Shots

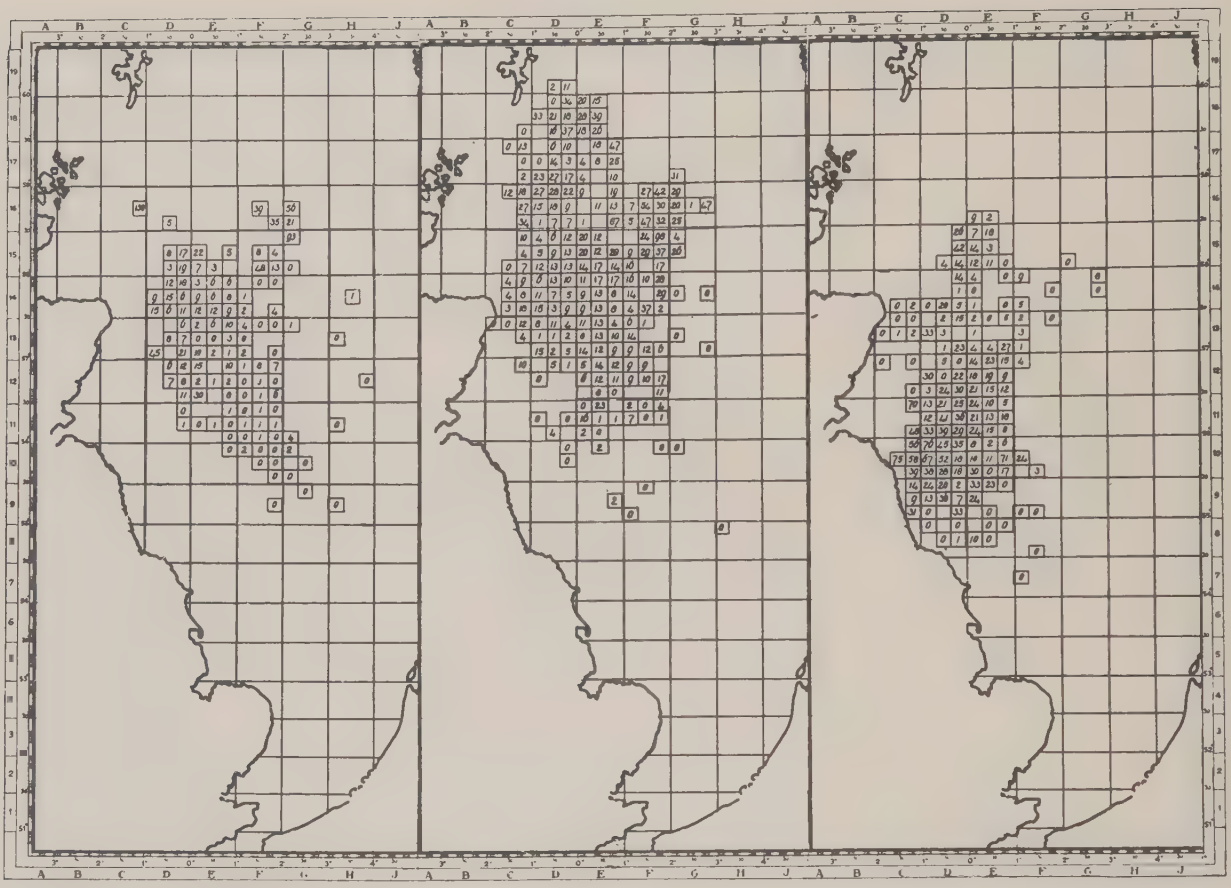


Charts 16–18. August September October



Charts 19–20. November December

Mean Catch per Shot (Kantjes)



Charts 21-23. May June July

Because of the correction applied and as more types of vessels have been included now, it is not possible to compare the charts directly with those of former years. On the other hand, a comparison between the old type of charts was rather deceiving as the average engine power of the trawlers had gradually increased.

Although a direct comparison for this year's data with those of former years seems hardly possible, we still may mention some characteristics of the 1957 fishing. The Fladen fishery was probably somewhat better than in 1956. The Dogger and Gut fisheries had certainly improved. The fishery in the Channel, however, showed still poorer results than in 1956.

In the months August—November a trawl fishery for herring was practised in the Smalls area (St. George Channel), giving an average catch of 6.6 tons per fishing day (corrected). In November—December a trawl fishery was carried out in the English Channel area, which is not shown in the charts. The average catch was 3.2 tons per day's fishing (corrected).

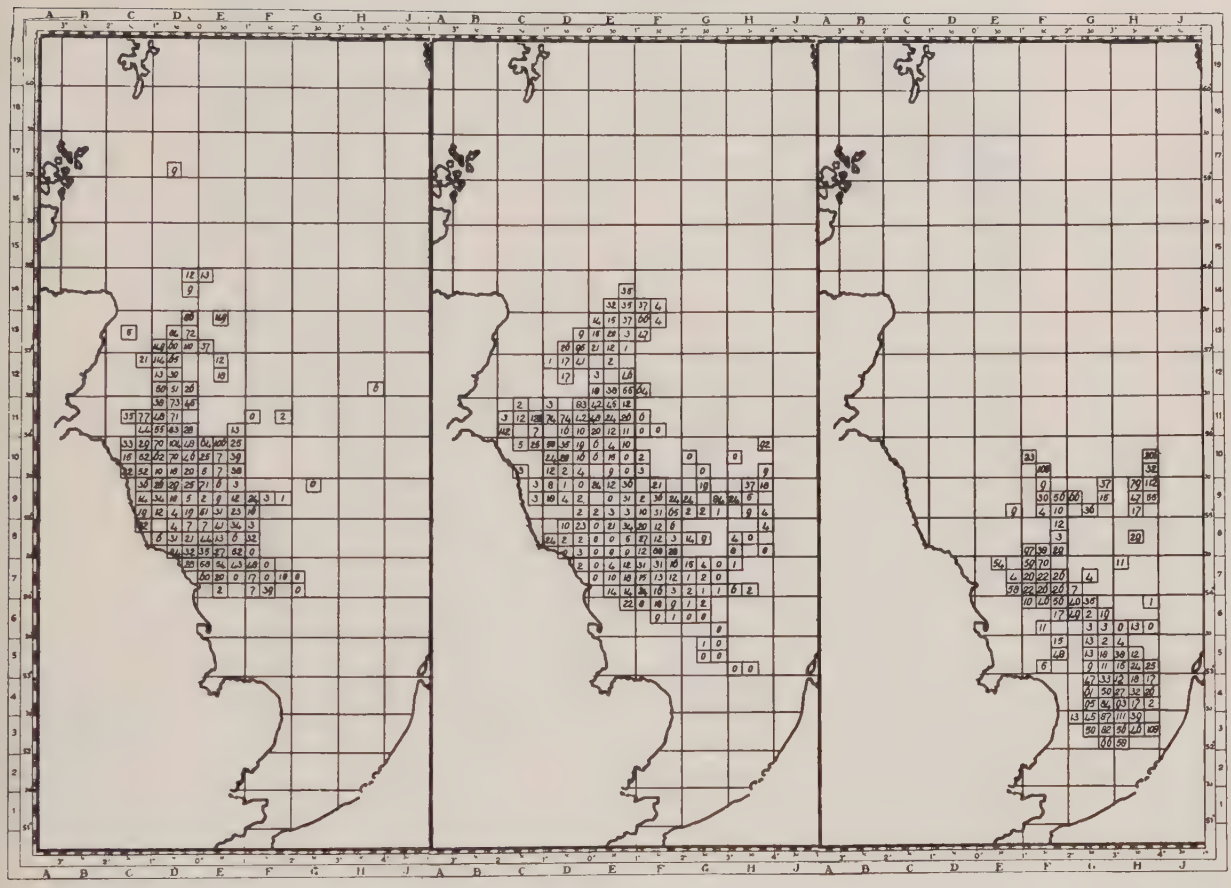
A new fishery started in the Dunmore area, on the S.E. coast of Ireland in December, which yielded very good results (7.0 tons per corrected day's fishing).

The total quantity of trawl herring landed in Holland in 1957 was 44,745 tons. The monthly landings can be found in Table 34 B.

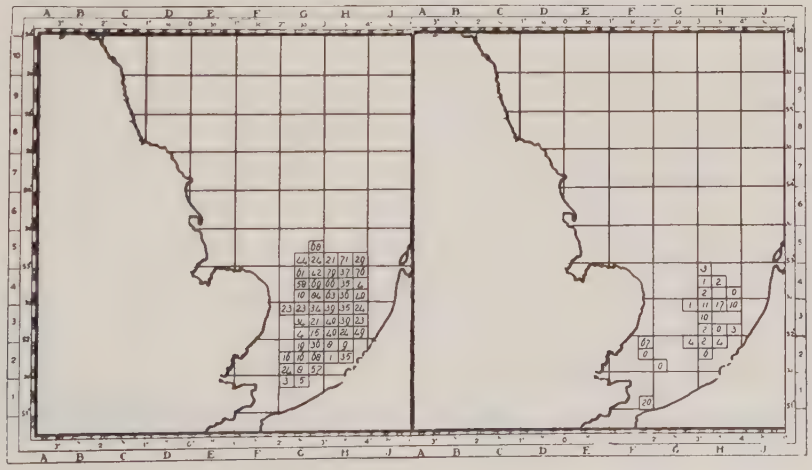
Age composition

As in 1956, investigations have been carried out on some herring trawl fisheries in spawning areas. Samples were collected from the trawl fisheries on the S.W. Dogger Bank (September—October), Sandettié area (November), English Channel (November—December), and the Dunmore fishery on

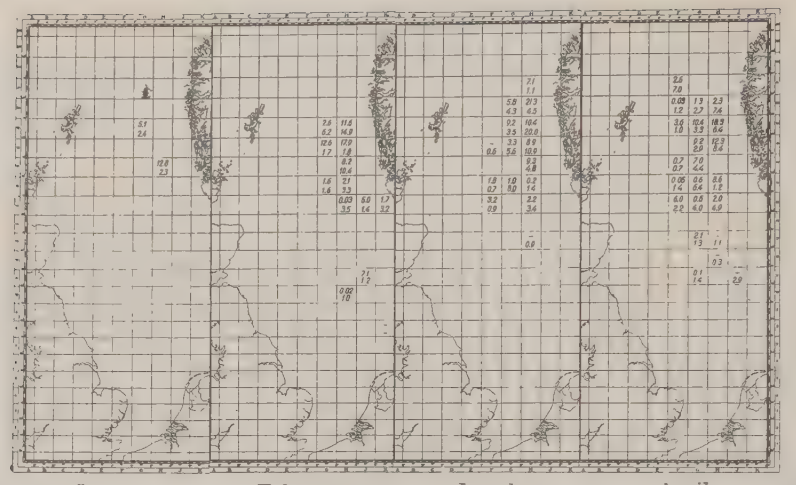
Mean Catch per Shot (Kantjes)



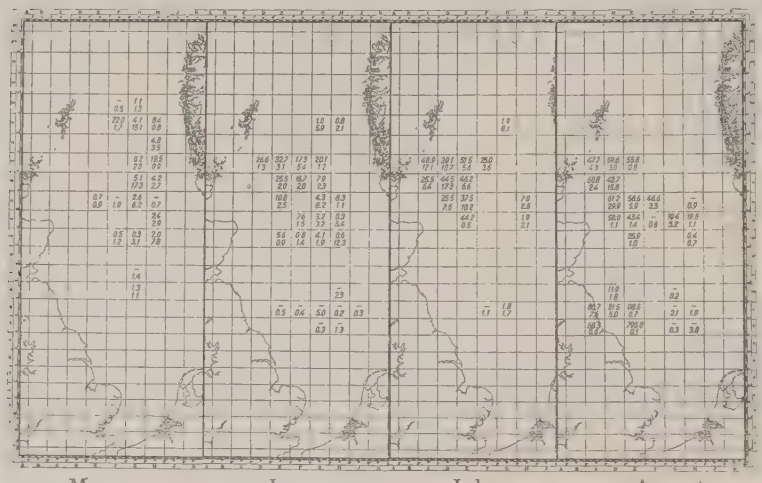
Charts 24-26. August September October



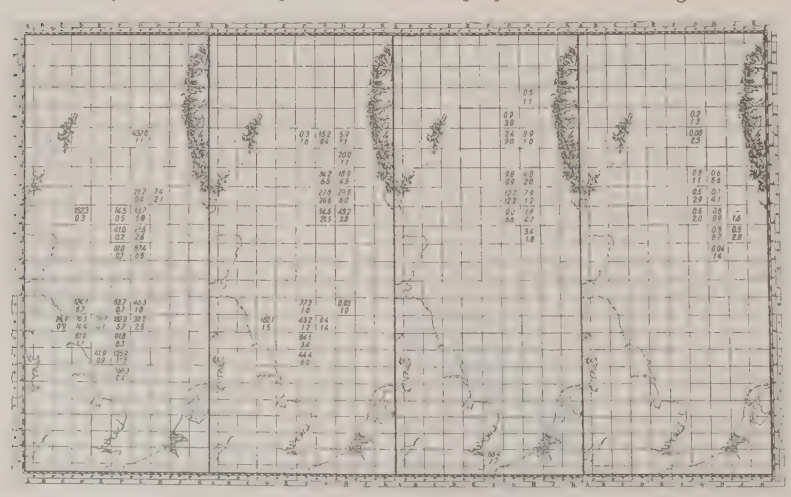
Charts 27-28. November December



January February March April



May June July August



September October November December

Charts 29-40. Dutch herring trawl fishery in 1958. In squares: upper figure: herring catches in tons per 100 hours' fishing. Lower figure: effort in 100 hours' fishing with motor-trawler of 500 B.H.P.

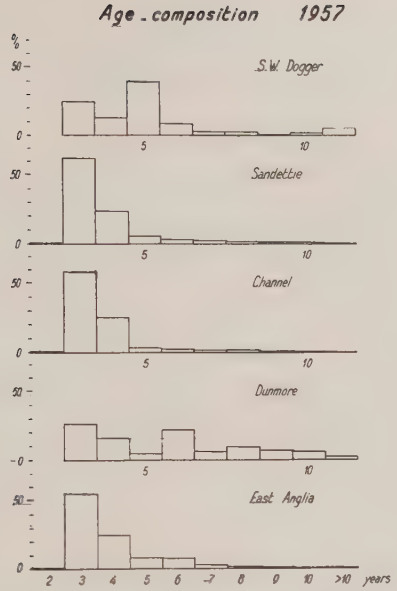


Figure 14. Age composition of spawning herring in the Dogger, Sandettié, Channel, and Dunmore areas (trawl), and from the East Anglian drift-net fishery.

the S.E. coast of Ireland (December 1957, January 1958). Most of these samples were taken from commercial vessels, a few were obtained with our research vessel "Willem Beukelsz".

The age compositions, shown in Figure 14, are based on herrings in maturity stage VI only.

A striking feature in the age compositions is the relatively high average age of the Dunmore herring. This could be due to the fact that the Dunmore trawl fishery is quite new which could imply that fishery mortality in this stock has been low thus far as compared with that of the North Sea herring stocks.

In addition to the age compositions of stage VI herring in the trawl fisheries, the age composition of the herring in the East Anglian drift-net fishery is presented in Figure 14. The age composition was calculated after HODGSON's method (1939).

K. H. POSTUMA, J. J. ZIJLSTRA

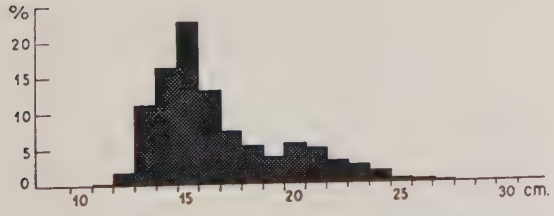


Figure 15. Total length distribution. Bløden fishery. Spring 1957.

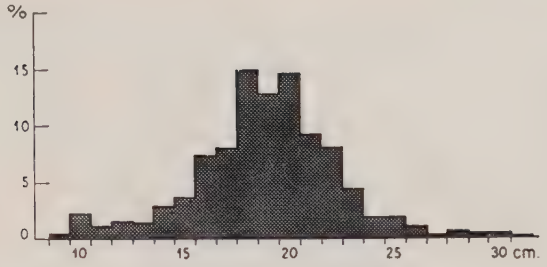


Figure 16. Total length distribution. Bløden fishery. Autumn 1957.

Young Herring from the Bløden Ground Area

(Figures 15–17)

The investigations concerning the Danish fishery in the eastern North Sea for young herring to the processing plants on the west coast of Jutland included a collection of statistics concerning fishing ground, catch, and effort during the autumn season. Routine work comprising market measurements, market sampling, and research trawlings were carried out as previously.

Spring season (January—April)

The fishery on the Bløden proper was reduced compared with 1956. The season started in the area of Silver Pit and to the west of Dogger. During the later half of the season the fishery mainly took place around Tail End and east of the Bløden area. The length distribution of the total catch is shown in Figure 15. The 1955 year-class made up 75.8%, while the 1954 year-class provided 20.5% of the total number of fish landed. Older age-groups amounted to 3.7%.

Autumn season (July—December)

Figure 17 shows the area covered by the cutter fleet and the amount of fish caught in each square. The cold bottom water retreated rather slowly and made possible a comparatively wide dispersion of the shoals, especially towards the south. The quite heavy catches near the coastal waters took place late in the season, after the discontinuity layer had dissolved and the cooling down had started in the coastal regions. Figure 16 shows the length distribution of the total catch landed at Esbjerg. Large fish of the 1956 year-class (0-group) were well represented and made up 22.4% of the total number of fish landed. Year-class 1955 and older age-groups accounted for 60.4 and 17.2% respectively. Research trawlings by "Dana" and "Jens Væver" revealed unusually dense concentrations of 0-group herring in the German Bight

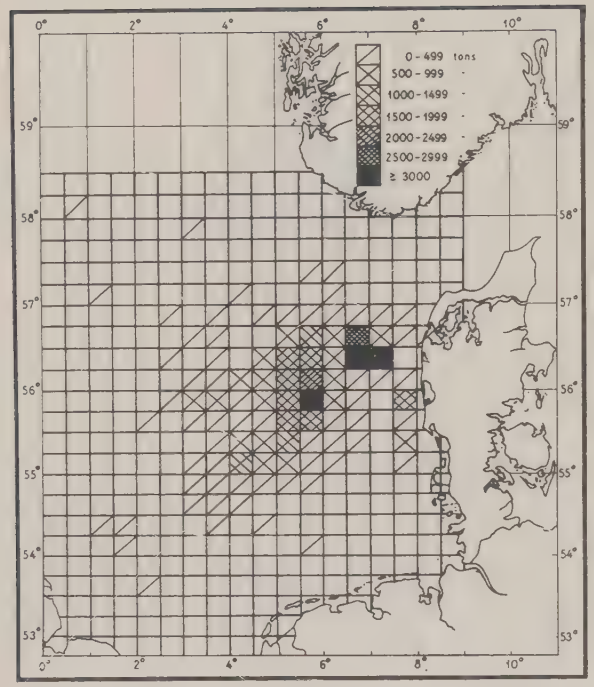


Figure 17. Fishing areas and yields. Bløden fishery. Autumn 1957.

and along the Jutland coast. It seems likely that the 1956 year-class is fairly strong in all spawning groups usually encountered in this area. Accordingly, the prospects for the fishery in 1958 seem to be fine.

Meristic characters

The average numbers of keeled scales and vertebrae as shown below were in accordance with previous observations:—

Year-class	1956	1955	1954
Spring	—	14.85 (125)	14.59 (360)
	—	56.53 (304)	56.63 (421)
Autumn	—	14.85 (141)	14.75 (48)
	56.52 (646)	56.59 (415)	56.55 (107)

The low average number of keeled scales in the 1954 year-class has been characteristic since the entry of this year-class into the autumn fishery of 1955.

K. Popp Madsen

The Belgian Herring Fisheries in 1957—1958

(Figure 18; Tables 35–49)

The North Sea — English Channel

1. Regions — fishing gear

Once again, it became apparent as from the beginning of the herring fishery that the season would not be very encouraging. So much so, that in the hope of finding denser herring concentrations, the Belgian fishermen visited other fishing grounds than those which they have usually exploited during previous seasons, viz. Utsira, situated in the N.E. part of the North Sea and the area between Boulogne and Dieppe in the eastern English Channel. A large part of the activity of the trawlers was also expended on the Smalls Ground.

The results obtained for the North Sea and the eastern English Channel are treated together whereas those for the Smalls are given separately.

In the northern and central areas of the North Sea, the fishery was exclusively carried out with the otter-trawl; in the southern area and in the English Channel only the pelagic trawl was used, towed by two trawlers fishing together.

As the efficiency of these two methods differs, the results are given separately for each method.

The total landings from this fishery amounted to 2,471 tons of fish, of which 1,969 tons of herring. The otter-trawl gave 602 tons of herring and the pelagic trawl 1,367 tons.

2. Otter-trawl: fishing effort — landings

In the northern and central areas of the North Sea, three regions were mainly exploited: Utsira (October—November), Fladen (August—September), and the Gut–Dogger Bank (August till October).

Tables 35—37 give records of fishing effort and the yield of the fishery, as regards vessels operating with the otter-trawl. Only 6 trawlers participated in the fishery and made 17 trips during the season (Table 35). The catches were mainly composed of herring (Table 36), the yield of which totalled 602 tons (Table 37) as against 616 tons in the previous season. The average catch per 100 F.H. × H.P. was 48 kg. or nearly the equivalent of the result of the previous season (47 kg.).

3. Pelagic trawl: fishing effort — landings

The use of the pelagic trawl was localized to the southern area of the North Sea and to the eastern English Channel.

In the southern area of the North Sea the fishery took place in the waters around the Sandettié light-

Table 35. Number of trips with otter-trawl and fishing effort

Months	Number of trips				Fishing effort (1,000 F.H. x H.P.)			
	Utsira	Fladen	Central	Total	Utsira	Fladen	Central	Total
August	—	3	1	4	—	183	84	267
September	—	2	6	8	—	191	412	603
October	3	—	1	4	233	—	40	273
November	1	—	—	1	114	—	—	114
Total 1957	4	5	8	17	347	374	536	1,257

Table 37. The yields of herring (otter-trawl)

Months	Total catch (tons)				Average catch per 100 F.H. × H.P. (kg.			
	Utsira	Fladen	Central	Total	Utsira	Fladen	Central	Tota
August	—	91	50	141	—	50	60	53
September	—	91	257	348	—	47	62	58
October	83	—	6	89	36	—	15	33
November	24	—	—	24	21	—	—	21
Total 1957	107	182	313	602	31	49	58	48

Table 38. Number of trips with pelagic trawl and fishing effort

Months	Number of trips			Fishing effort (1,000 V. × H.P.)		
	Sandettié	Boulogne-Dieppe	Total	Sandettié	Boulogne-Dieppe	Total
October	8	—	8	3	—	3
November	47	29	76	18	10	28
December	21	39	60	8	15	23
January	—	39	39	—	14	14
Total 1957—58	76	107	183	29	39	68

Table 39. The yields of herring (pelagic trawl)

Months	Total catch (tons)			Average catch per 100 V. × H.P. (kg.)		
	Sandettié	Boulogne-Dieppe	Total	Sandettié	Boulogne-Dieppe	Total
October	9	—	9	310	—	310
November	299	123	422	1,698	1,164	1,498
December	94	530	624	1,223	3,608	2,790
January	—	312	312	—	2,207	2,207
Total 1957—58	402	965	1,367	1,421	2,450	2,020

vessel and in the eastern English Channel off the French coast between Boulogne and Dieppe.

The first catches from the Sandettié were landed on 26. October and the last on 11. December 1957. In the Boulogne-Dieppe area the fishery started at the beginning of November 1957 to finish on 31. January 1958.

Table 38 gives a survey of the fishery effort and the yields. This year 18 trawlers took part in the fishing in the Sandettié area and 22 in the sector Boulogne-Dieppe. A total of 183 voyages were

Table 36. The total yields by otter-trawl vessels

Species	Tons	‰
Pelagic Herring	602	628
,, Mackerel	232	242
,, Others	1	—
Demersal Haddock	37	38
,, Whiting	34	36
,, Saithe	25	26
,, Cod	19	20
,, Others	9	10
Total pelagic species	835	870
Total demersal species	124	130
Grand total	959	1,000

Table 40. Number of vessels, number of trips, and fishing effort

Months	July	August	September	October	November	December	January	Total
Number of vessels	2	7	8	5	2	1	3	12
Number of trips	2	15	14	8	3	2	5	49
Fishing effort (1000 F.H. × H.P.) ...	63	563	589	355	114	48	90	1,822

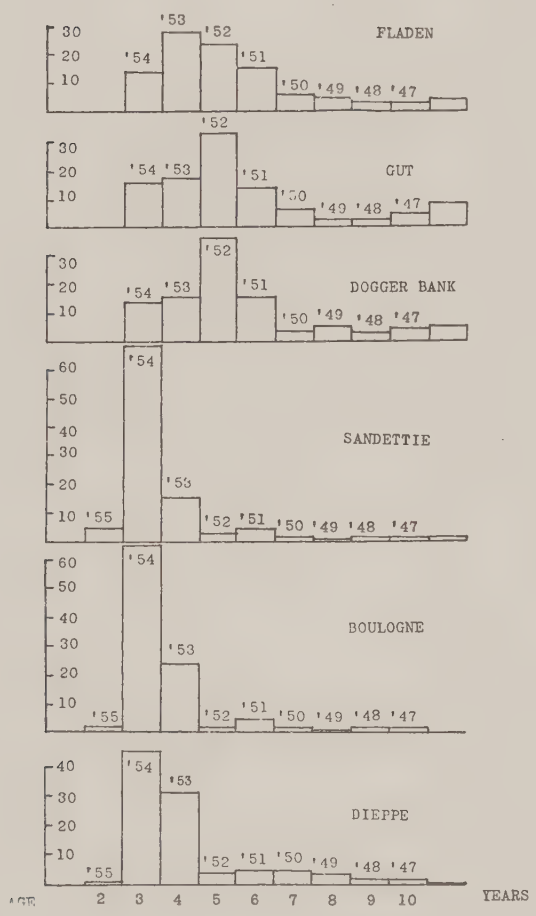


Figure 18. Biological scale of the herring concentrations exploited by the Belgian herring trawlers during 1957–1958 in six areas.

made; Sandettié (76) and Boulogne-Dieppe (107).

The total catch amounted to 1,512 tons of fish consisting of 1,367 tons of herring or 90.4%, 122 tons or 8.0% sardines, 2 tons or 0.2% mackerel, and 21 tons or 1.4% demersal species.

Table 39 gives details as regards the landings made with the pelagic trawl. The average catch per 100 V. × H.P. reached for the two areas 2,020 kg. (V. = voyages); for Sandettié 1,421 kg. and for Boulogne-Dieppe 2,450 kg. Compared with the previous season (1,645 kg.) it showed a decrease of 224 kg., or 13.6%, for the Sandettié area.

The Smalls

1. Activity and landings

During 1957, the otter-trawl was exclusively used during the full-herring fishery on the Smalls and off Dunmore. The first herring of the Smalls was landed on 23. July and this fishery ended at the end of November. Off Dunmore, the fishery lasted from the beginning of December 1957 until the end of January 1958.

The total landings of this fishery amounted to 1,598 tons of which 1,340 tons were herring (83.8%), species of pelagic fish (mackerel) 38 tons (2.4%), and of demersal fish 220 tons (13.8%).

2. Fishery

Tables 40—42 give records of the fishing effort and the yields of the fishery. Twelve trawlers were engaged in the fishery and made 49 trips during the season (Table 40). The catches of herring reached 1,340 tons (Table 41). The average catch per 100 F.H. × H.P. was 74 kg.

Table 41. The total yields (otter-trawl)

Species	Tons	‰
Pelagic Herring	1,340	838
,, Mackerel	38	24
Demersal Whiting	80	50
,, Saithe	58	36
,, Cod	34	22
,, Others	48	30
Total pelagic species	1,378	862
Total demersal species	220	138
Grand total	1,598	1,000

Table 42. The yields of herring (otter-trawl)

Months	July	August	September	October	November	December	January	Total
Total catch (tons)	30	494	372	183	58	41	162	1,340
Average catch kg. per 100 F.H. × H.P.	48	88	63	51	51	86	181	74

Table 43. Size, weight, and sex (‰)

cm.	Fladen	Gut	Dogger Bank	Sandettié	Boulogne	Dieppe	Utsira	Smalls
32	—	—	—	—	—	—	17	—
31	17	51	38	—	—	3	159	2
30	97	102	107	9	14	24	**283**	49
29	150	153	**214**	25	20	55	214	149
28	**189**	**184**	207	34	29	75	165	**220**
27	150	163	172	37	34	41	55	198
26	141	174	100	93	88	137	45	178
25	102	112	79	107	166	178	45	111
24	107	61	66	253	200	**219**	17	74
23	49	—	17	**284**	**317**	207	—	17
22	—	—	—	132	112	46	—	2
21	—	—	—	23	20	12	—	—
20	—	—	—	3	—	3	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000
Average length, mm.	274	279	281	245	241	250	294	274
Mode, cm.	28	28	29	23	23	24	30	28
Weight, g.	185	174	178	104	110	106	185	186
Males, ‰	495	510	441	414	522	376	438	434

The Herring Stock

Owing to the scarcity of the herring on the usual fishing grounds exploited by the Belgian fishermen other areas were visited in the hope of finding more remunerative catches.

The herring fishery covered thus a rather larger area than usual and the samples originate from many different areas. Also, the number of observations for certain areas is not sufficient for drawing any conclusions concerning the affinity of the herring caught in these areas.

As the herring from Utsira are rather different from those of the other regions of the North Sea, the results of their analysis are given separately. The results of the Smalls herring form also a separate chapter.

The herring of the North Sea and the eastern English Channel

A total of 1,569 herrings was investigated; the fish were collected from the Fladen (206, August), the Gut (98, September), the Dogger Bank (290, September), the Sandettié (355, November), off Boulogne (205, November—December), and off Dieppe (415, December—January).

Table 43 shows the size distribution of the herring for each fishing area. The average weight and the percentage number of males are also recorded. The average size of the fish was 279 mm. for the area Fladen—Gut—Dogger Bank, and 249 mm. for the area Sandettié—Boulogne—Dieppe. The average weight was 175 g. and 106 g. respectively.

Table 44 gives the stages of maturity for these areas. This shows that the herring concentrations of the Fladen consisted mainly of full herring, those of the Dogger Bank of ripe herring, and those of the four other areas of spent herring. As in previous years the quantity of intestinal fat was estimated. The results are shown in Table 45.

The composition of the catches, as to age, is demonstrated in Table 46. The 4- and 5-year-old fish were predominant in the first area and the 3-year-olds in the second area. The sequence of the most important year-classes, as to their relative strength proved to be as follows: for the first area — the classes 1952 (291‰) and 1953 (194‰), for the second area, the 1954 class (586‰).

The average length of the herring and the growth-rate during the first year (L_1) are given in Table 47.

Table 44. Stages of maturity (‰)

Stages	Fladen	Gut	Dogger Bank	Sandettié	Boulogne	Dieppe	Utsira	Smalls
I	—	10	—	68	20	14	—	2
II	15	10	—	99	15	10	41	4
III	73	21	3	—	—	—	190	116
IV	189	60	24	3	—	—	86	**451**
V	**480**	174	204	76	122	14	28	401
VI	15	51	**597**	115	395	12	—	2
VII	10	10	79	39	5	7	3	2
VIII—II	218	**664**	93	**600**	**443**	**943**	**652**	22
Total	1000	1000	1000	1000	1000	1000	1000	1000

Table 45. Quantity of intestinal fat (‰)

Quantity	Fladen	Gut	Dogger Bank	Sandettié	Boulogne	Dieppe	Utsira	Smalls
0	267	153	479	279	390	234	7	23
1	**476**	**776**	**490**	**552**	**576**	**742**	**645**	395
+	204	51	31	104	24	19	334	**555**
M	53	20	—	65	10	5	14	27
Total	1000	1000	1000	1000	1000	1000	1000	1000
Index	2.04	1.94	1.55	1.96	1.65	1.80	2.36	2.59

Table 46. Age (‰)

Age	Year-class	Fladen	Gut	Dogger Bank	Sandettié	Boulogne	Dieppe	Utsira	Smalls
2	1955	—	—	—	48	19	3	—	—
3	1954	140	154	134	**686**	**652**	**463**	52	93
4	1953	**272**	173	152	151	236	319	78	221
5	1952	235	**327**	**361**	30	13	39	**290**	107
6	1951	155	135	152	40	37	49	110	**248**
7	1950	59	58	36	15	13	49	161	110
8	1949	44	19	45	4	6	36	161	128
9	1948	29	19	27	7	12	16	97	60
10	1947	29	38	40	7	12	19	32	18
+10	<1947	37	77	53	11	—	7	19	15
Total		1000	1000	1000	1000	1000	1000	1000	1000
Average age (years-months)		5.4	5.8	5.7	3.7	3.7	4.2	6.5	6.10

Table 47. Average lengths by age and the value of L_1 (mm.)

Average length by age in mm.

Brood	Fladen	Gut	Dogger Bank	Sandettié	Boulogne	Dieppe	Utsira	Smalls
1955	—	—	—	223	217	224	—	—
1954	246	255	251	239	240	241	253	250
1953	266	269	269	258	256	260	275	264
1952	281	279	283	276	278	279	290	277
1951	289	294	291	283	286	283	298	282
1950	293	295	299	289	287	290	303	288
1949	302	310	298	283	295	294	305	292
1948	304	298	308	296	298	298	304	295
1947	302	309	302	303	297	302	311	296

Average value of L_1 in mm.

L_1								
1955	—	—	—	145	160	176	—	—
1954	140	125	138	123	124	124	140	132
1953	134	127	131	124	122	124	131	123
1952	133	132	136	130	143	134	139	126
1951	134	133	130	135	140	138	131	129
1950	132	115	122	120	133	121	133	132
1949	131	136	120	132	144	119	120	125
1948	121	109	119	120	116	105	132	122
1947	117	97	120	136	116	125	124	133

The number of vertebrae observed per spine varies between 54 and 59 for the herrings of the North Sea and between 53 and 60 for those of the eastern English Channel (Table 48). The spines with 57 vertebrae predominate.

Finally Table 49 gives the number of keeled scales (K_2) for each fishing ground.

Stomach analyses were made on all herring investigated. Only 0.6% were found to contain food, mostly remains of copepods.

The herring of Utsira and those of the Smalls

A total of 290 herrings collected during the period October and November on the Utsira fishing ground were investigated, as well as 636 herrings

Table 48. Vertebrae (V.S. $^0/_{00}$)

V.S.	Fladen	Gut	Dogger Bank	Sandettié	Boulogne	Dieppe	Utsira	Smalls
60	—	—	—	—	—	3	—	—
59	—	—	3	3	5	3	4	3
58	40	42	43	67	55	66	73	136
57	450	**469**	**464**	**451**	**594**	**558**	**538**	**576**
56	**485**	427	447	398	291	332	360	256
55	20	52	43	81	50	33	25	26
54	5	10	—	—	—	5	—	3
53	—	—	—	—	5	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000
Average	56.500	56.479	56.518	56.512	56.653	56.665	56.671	56.826
Standard error	0.6643	0.7033	0.6651	0.7508	0.7287	0.7075	0.6643	0.7108
Fluctuation mean	0.1517	0.2420	0.1336	0.1364	0.1743	0.1207	0.1325	0.0959

Table 49. Keeled scales (K_2) in $^0/_{00}$

K_2	Fladen	Gut	Dogger Bank	Sandettié	Boulogne	Dieppe	Utsira	Smalls
20	5	—	—	—	—	2	—	—
19	—	—	—	—	5	—	—	—
18	5	10	—	—	—	2	4	—
17	24	10	25	25	25	15	11	7
16	83	112	146	136	113	124	89	87
15	**456**	**449**	**441**	**431**	**473**	**510**	328	415
14	373	398	335	346	310	313	**446**	**427**
13	54	21	53	62	69	32	118	64
12	—	—	—	—	5	2	4	—
Total	1000	1000	1000	1000	1000	1000	1000	1000
Average	14.691	14.724	14.754	14.717	14.719	14.789	14.428	14.545
Standard error	0.9184	0.8053	0.8563	0.8664	0.9198	0.8168	0.8938	0.7706
Fluctuation mean	0.2167	0.2743	0.1723	0.1555	0.2177	0.1025	0.1835	0.1081

collected during August, September, and October on the Smalls.

As the results of the analyses of the herring originating from these two areas do not call for any comments, the figures obtained for each biological value investigated are given in the corresponding tables covering the results of the North Sea and eastern English Channel herring.

General observations and conclusions

From the point of view of length and age the region exploited by the Belgian herring trawlers may be divided into two very distinct areas: the first comprising Fladen, Gut, and Dogger Bank; the second the Sandettié, the Boulogne and Dieppe sectors.

In the first area the herring are relatively large and aged: average length 278 mm. and 5 years and 6 months old, whereas in the second area, the figures are 249 mm. and 3 years and 10 months old respectively.

Concerning the year-classes observed in the two areas, in the first the year-classes 1952 (5-year-olds) and 1953 (4-year-olds) predominate with $291^0/_{00}$ and $194^0/_{00}$ and in the second area, the 1954 year-class (3-year-olds) is represented by $586^0/_{00}$.

The comparison of the vertebral average shows a clear distinction between the herring from the North Sea and those of the eastern English Channel. The vertebral average for the North Sea varies between 56.479 and 56.518. The average for the eastern English Channel between 56.653 (Boulogne) and 56.665 (Dieppe).

From the few preceding remarks, we may conclude that:—

(1) the scarcity of large and old herring observed on the Sandettié and in the eastern English Channel means probably that these herring remained in the northern area of the North Sea, whereas the young herring in large numbers penetrated into the southern area and perhaps also, however to a lesser degree, into the eastern English Channel;

(2) the vertebral average tends to show a very close affinity between all the herring from the North Sea while it differs greatly from the average of the eastern English Channel. Thus it may well be that the concentrations of the eastern English Channel constitute a mixture of herring of the southern North Sea and, principally, of those from the western English Channel;

(3) the great difference between the vertebral averages of the Sandettié herring and those of the eastern English Channel would exclude a penetration of these herring into the North Sea;

(4) the very high percentage of the 3-year-old herring (1954 year-class) observed from the Sandettié and the eastern English Channel is rather a bad omen for the yields of the future herring campaigns in these two areas.

CH. GILIS

Age and Length of Herring in Polish Trawl Catches in the Farn Deep—East Bank Area in August and September 1957

Table 50a. Length distribution (‰)

cm.	19	20	21	22	23	24	25
1957	1	7	8	64	170	249	171
cm.	26	27	28	29	30	31	32
1957	115	83	64	45	17	4	2

Number . 3,203

Table 50b. Age distribution (‰)

Years	2	3	4	5	6	7	8	9	10
1957	40	620	176	104	31	11	11	4	3

Number 596

The catches mainly consisted of 3-year-old herring from the 1954 year-class.

J. POPIEL

[1]) Condensed from the report: "ICES Herring Tagging Experiment at the Bløden Ground" (unpubl.).

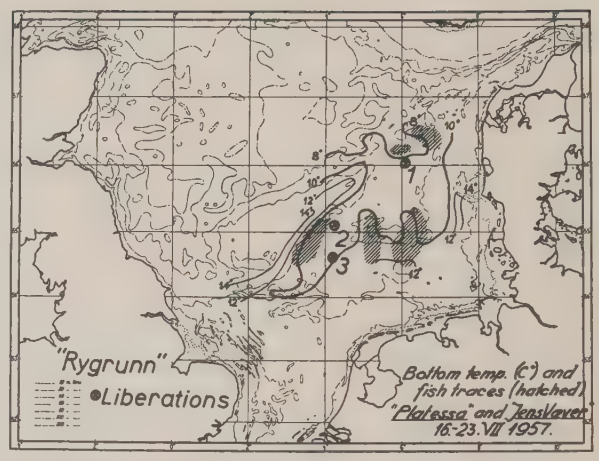


Figure 19. Explanation, see text.

ICES Herring Tagging Experiment at the Bløden Ground[1])

(Figure 19; Tables 51–53)

A rather unusual event in herring research took place in the summer of 1957 when 7 countries (Denmark, German Federal Republic, Netherlands, Poland, Sweden, U.K., and U.S.S.R.) made a co-ordinated effort under the administration of ICES to launch a large-scale tagging programme on the Bløden Ground immature herring. Norway participated by giving technical assistance.

Before the tagging work started, the area was surveyed by the research vessels "Jens Væver"

Table 51. Survey of released tags and participating ships

Ships	Date	Types of tags: Internal tags		Lea tags		Danish Lea		Hodgson tag	Scottish combinations tags	
		P	T	P	T	P	T	P	D	T
"Rygrunn"	24/7—19/8	9930	—	—	—	—	—	—	—	—
"Sir Lancelot"	10/8—26/8	—	1739	12	177	—	—	379	—	—
"Clupea"	7/8—27/8	—	592	—	119	—	—	—	96	1300
"Jens Væver"	16/7—14/8	—	50	51	—	74	—	—	—	—
"Platessa"	18/7—24/7	—	Pre-tagging survey only							

P = purse-seine, T = trawl, D = drift-net.

Table 52. Number of tags returned each week

Week	Lib. 1, 4041 tags 5. August			Lib. 2, 1989 tags 14. August			Lib. 3, 3900 tags 17. August		
	Es.	o. Da.	Ge.	Es.	o. Da.	Ge.	Es.	o. Da.	Ge.
32 (4/8—10/8)	29	2	—	—	—	—	—	—	—
33 (11/8—17/8)	48	1	—	—	—	—	—	—	—
34 (18/8—24/8)	48	14	1	85	—	37	3	—	32
35 (25/8—31/8)	5	1	—	6	—	—	3	—	2
36 (1/9— 7/9)	5	3	—	2	—	—	9	—	4
37 (8/9—14/9)	7	0	—	3	—	—	1	1	0
38 (15/9—21/9)	0	0	—	0	—	1	0	—	0
39 (22/9—28/9)	9	0	—	3	1	—	0	—	0

Table 53. Tags caught per 100 hours' fishing per square per 1000 fish tagged

Week:	32	33	34	35	36	37	39
Liberation 1 ...	5.5	8.7	10.2	3.0	1.0	3.2	3.0
Liberation 2 ...	—	—	5.0	12.0	0.3	7.5	10.7
Liberation 3 ...	—	—	6.7	7.5	13.2	—	—

(Denmark) and "Platessa" (U.K.). The result of this survey is given in Figure 19, where also the positions of the 3 major liberations of internally tagged (purse-seine caught) herring are shown.

A Norwegian purse- seiner, M/S "Rygrunn", was chartered to provide live material and serve as tagging vessel. Three research ships participated as survey and tagging vessels during the experiment. In Table 51 is given a survey of the time spent at sea by the different ships, together with the number of released tags of various types arranged according to mode of catching. In all, 33 liberations of tagged herring were made comprising 14,519 tags.

The bulk of the catches, and the return of tags, occur during the first six weeks following marking. In Table 52 are given the returns each week of internally tagged, purse-seine caught herring, separated according to the place of landing (Esbjerg, other Danish ports, or Germany) for the liberations referred to in Figure 19. The number of tags released and the tagging dates are also given.

For the Esbjerg landings the Danes succeeded in collecting comprehensive catch/effort statistics in 15 × 15 mile squares. Using these statistics and certain weighting factors an estimate of recaught tags per 100 hours' fishing per square per 1000 fish tagged has been made (see Table 53).

In spite of a considerable variation in the figures, it is worth noting that a line decreasing from 6.0 to 4.0 in 8 weeks is a reasonable fit. During the time of tagging the catch/effort was about 50 tons per 100 hours. From these figures is derived the density:

$$50 \times \frac{1000}{6} = 8{,}333 \text{ tons per square.}$$

Assuming equal density in the whole area the estimate of the size of the exploited stock at the time of tagging is

$$60 \times 8{,}333 = 500{,}000 \text{ tons.}$$

The total catch of the tagged stock is estimated to 61,787 tons. The percentage taken of the stock at the beginning of the season is therefore 61.8/500 = 12.4%. The efficiency of the magnetic separators in the Esbjerg reduction plants is by testing observed to be 0.95. Using this correction factor, the following corrected figures are obtained:—
tags returned per 100 hours' fishing per square = 6.3
weight of stock at marking = 475,000 tons
percentage taken by the Bløden fishery = 13.0%.

Olav Aasen

C. Baltic-Belt Seas

COMMERCIAL FISH

Report on Swedish Herring Tagging in the Baltic

(Figures 20—21; Table 54)

In 1957 we proceeded with our tagging experiments in the Baltic area. As a supplementary note to the report given in the last issue of Ann. Biol. (13: 213—15) some information will be given on the taggings in the Baltic proper.

Three taggings in 1957 were made on the Swedish east coast between Trosa and Västervik. The number of fish marked with the Lea tag was 1443. For further details, see Table 54.

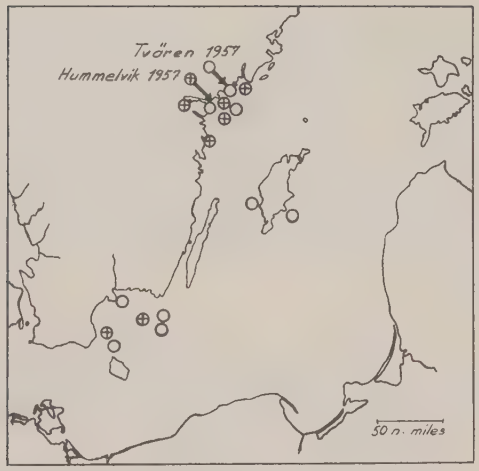
The very high percentage of recovery from the Källvik tagging is attributed to a large number of records after a few days in the tagging area. The difference between the values from Tvären and Hummelvik is probably a result of the different fishing activities in the coastal waters and of the tagging in separate periods.

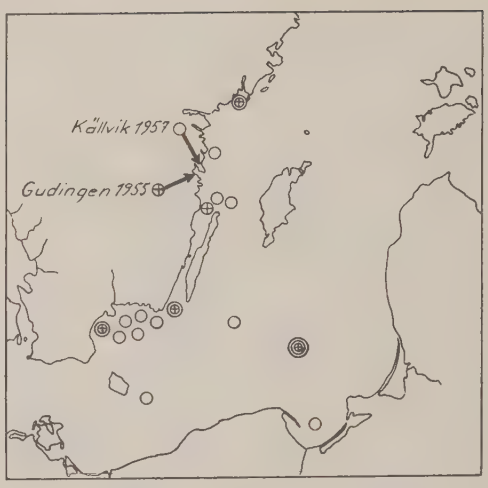
Table 54.

Tagging locality	Date	Number tagged	% recovered until 1. Jan. 1958
Tvären, between Trosa and Nyköping	10.–14. V.	542	3.1
Hummelvik, E. of Norrköping ...	12.–14. III.	701	9.4
Källvik, N. of Västervik	21. V. and 14. VI.	200	18.5

As far as known, exclusively spring or early summer spawning herring are included in the experiments.

Most remarkable is the high number of recoveries in the southern Baltic: 14 from the experiments





Figures 20 and 21. Long-distance records from four tagging experiments in the Baltic proper. The tagging locality is indicated with an arrow. A large number of recoveries in or near the tagging area are omitted. Single symbols = recoveries in the year of tagging. Records from the next two years are marked with one and two rings respectively around the symbols.

mentioned. Already at the beginning of July two were reported from Gothland and in August the first records were made from the Hanö Bay and the Midwater Banks. Further recoveries were reported from the southern Baltic in the period September—November (cf. Figures 20–21). Fish four years old and older are represented among the long-distance records, the older are in majority.

In Figure 21 three recoveries are mapped in the southern Baltic from the tagging at Gudingen in 1955 (cf. Ann. Biol., 13). They are from January, May, and April (enumerated from W.—E.).

Our recoveries from these preliminary taggings in the Baltic proper show that important migrations are undertaken by the herring from the Swedish east coast south of Stockholm to the waters in the southern Baltic. This result is in agreement with the hypothesis of Popiel (see Rapp. et Proc.-Verb., 143, II, p. 114) that the most important stock of spring spawning herring on the open-sea fishing grounds in the southern Baltic is spawning on the Swedish coasts.

G. Otterlind

Composition of the Herring Stock in the Southern Baltic

(Table 55)

The age and length composition of spring spawners on the fishing grounds of the southern Baltic during the summer/autumn feeding period are presented in Table 55.

This herring, belonging probably to a stock of the central Baltic, contributed last year about 70% to the total Polish catches of Baltic herring.

The most numerous year-classes in both areas were those of 1949, 1952, and 1953.

The catch per day's fishing (according to H. Janko) in the summer/autumn season, when this stock of herring predominated in the landings has distinctly decreased, as shown below:—

Year	Gdańsk Bay	Bornholm Basin
1952	149 kg.	479 kg.
1953	259	504
1954	262	581
1955	200	944
1956	478	786
1957	85	688

Table 55. Length distribution (‰)

cm.	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Gdańsk Region	2	7	44	135	149	164	122	109	96	87	44	27	8	3	2	1
Bornholm Basin	2	4	40	107	136	164	82	67	96	136	121	31	12	2	—	—

Age composition (‰)

Age	2	3	4	5	6	7	8	9	10	11	12+
Year-classes	1956	1955	1954	1953	1952	1951	1950	1949	1948	1947	—
Gdańsk Region ...	15	117	87	184	177	62	85	111	75	32	55
Bornholm Basin ..	29	56	121	182	121	94	100	121	97	40	39

This was especially conspicuous in the Gdańsk region.

The local stock of herring spawning in brackish water of the Gdańsk and Pomorska Bays, gave also low catches during the spawning season in spring.

The landings of autumn spawners were lower than expected on the basis of the good catches in 1956, when a number of young and abundant year-classes were observed. The most prominent year-classes in 1957 were those hatched in autumn 1952 and 1954.

In general, the Baltic herring fishery was very poor in 1957, especially when compared with the very good catches landed in 1956.

The quality of the herring was much better than in 1956. The length-weight coefficient (maturity II—III) rose in the Gdańsk region from 0.580 in 1956 to 0.696 in 1957, and in the Bornholm Basin from 0.602 in 1956 to 0.712 in 1957. The rate of growth was also better in 1957. The length of the 2-year-old spring herring (L_2) in Gdańsk Bay was about 18 cm. as compared with the average of 17 cm. and 15 cm. in 1956.

J. Popiel, J. Elwertowski

Danish Herring Investigations in the Skagerak, Kattegat, Belts, and Baltic

(Tables 56—59)

1. Young herring in the Skagerak and northern Kattegat

In the first quarter of the year the herring were mostly of 10—22 cm. length (see Table 56). About half of them, under 15 cm. in length, were Atlanto-Scandian spring herring or the closely related Kattegat winter herring (A. C. Johansen) (see Table 57). Actually the racial characters found in the samples are those of the Kattegat winter herring, but the herring analysed have been divided arbitrarily according to length, and the other component of the stock must comprise also part of the herring under 15 cm. length. It is unusual that young herring of the Atlanto-Scandian group are so abundant in the Skagerak.

The other component of the stock was found mainly among the herring more than 15 cm. long; these fish were autumn spawners from the western North Sea belonging to the 1955 year-class. The very high K_2 shows that they resembled mostly the races from the Berwick coast or the Dogger

Table 56. Length distribution (‰) of young herring in Danish commercial catches from the Skagerak and northern Kattegat in 1957

P = pound net, S = seine, T = trawl. Sk = Skagerak, K = Kattegat

Date	30. 1.–27. 3.	8. 5.–17. 5.	31. 5.–5. 6.	26. 6.–22. 7.	13. 9.	2. 9.–23. 9.	9. 10.–22. 10.	14. 11.	26. 11.	10. 12.	10. 12.
Region	Sk, K	K	Sk, K	Sk, K	K	Sk	K	Sk	K	K	Sk
Depth, m.	28–170	c. 5	5–90	c. 5–42	c. 5	60–72	28–35	30–64	28–38	27	76
Gear	T	P	P, T	S, T	P	T	T	T	T	T	T
No. of samples	12	2	5	6	1	7	5	3	4	2	1
cm. 3	—	15	—	—	—	—	—	—	—	—	—
4	—	129	—	—	—	—	—	—	—	—	—
5	—	515	—	—	—	—	—	—	—	—	—
6	—	300	—	31	4	—	—	—	—	—	—
7	—	40	—	338	648	—	—	—	—	5	—
8	—	—	—	488	331	—	6	—	3	5	—
9	1	—	—	108	13	1	44	—	25	16	—
10	2	—	—	28	4	7	192	6	129	72	—
11	12	—	—	6	—	60	277	17	263	253	8
12	29	—	6	—	—	118	274	110	274	334	45
13	118	—	26	—	—	310	165	196	182	234	188
14	158	—	78	1	—	226	37	262	107	56	308
15	176	—	155	—	—	38	4	107	18	16	278
16	157	—	210	—	—	—	—	32	—	7	98
17	66	—	139	—	—	—	—	9	—	2	23
18	89	—	162	—	—	—	—	9	—	—	8
19	81	—	68	—	—	—	—	46	—	—	15
20	73	—	74	—	—	—	—	107	—	—	15
21	21	—	45	—	—	—	—	72	—	—	15
22	13	—	16	—	—	—	—	26	—	—	—
23	3	—	13	—	—	—	—	3	—	—	—
24	—	—	6	—	—	—	—	—	—	—	—
25	1	—	—	—	—	—	—	—	—	—	—
Total	1002	999	998	1000	1000	999	999	1002	1001	1000	1001
Number invest.	1086	520	309	1080	236	703	707	347	628	431	133

Bank but, as our knowledge of the three fundamental characters, V.S., V.P., and K_2 is not sufficient as regards the spawning communities of the North Sea, it is not possible to state with certainty to which spawning ground they belong. As far as our present knowledge goes they cannot belong to the Minch, the Gut, or the Downs population.

In May a new component came into the fishery, namely herring of 3—4 cm. length. Their racial characters show that they were autumn spawners of the North Sea. The V.S. excludes the coastal spawners and the V.S., V.P., and K_2 exclude the Downs herring, the V.P. the Shetland-Scotland group, and the K_2 especially makes it improbable that they are Dogger Bank herring or from the Gut, although they might seem to be most similar to these two groups. Again is felt the lack of sufficient knowledge of the racial characters of herring from each of the various spawning grounds of the North Sea. In May—July these herring of the 1956 year-class were extraordinarily abundant at the coasts, afterwards they spread over the open sea. Their length in July was about 8 cm., in September about 13 cm., and in November about 15 cm. During the second half of the year they predominated the catch of young herring; among the small herring, however, one pound-net sample from 13. September consisted of autumn herring from the Jutland coast. It must be supposed that the value for K_2 should be higher than found in this sample on account of the small size of the herring.

The herring of more than 15 or 16 cm. length were a mixture of the two race-groups found in the first quarter of the year. Their length increased from about 17—19 cm. in May—June to about 20 cm. in September, and about 21 cm. in November (comp. Tables 56—57).

Table 57. Racial characters of young herring in samples from the Danish commercial fishery in 1957

Locality/Month	cm.	V.S. Mean	V.S. No.	V.P. Mean	K_2 Mean	K_2 No.
The Skagerak and northern Kattegat						
Jan.–March	9–14	56.89	258	24.31	14.44	227
	14–17	56.47	301	24.12	14.81	401
May–December .	4–16	56.52	1067	23.53	14.42	442
13. September ..	7– 8	56.37	217	24.14	14.53	211
September	17–23	56.90	143	24.10	14.45	130
December	15–21	56.54	37	23.43	—	—
The southern Kattegat						
July–November	8–17	56.25	289	24.51	14.24	329
31. July	9–12	56.45	145	23.89	14.31	101
The Belts and Baltic						
Aarhus Bay	8–11	57.00	69	24.29	14.40	29
9. 1.–15. 4.	12–18	55.88	889	23.69	14.10	757
N. Great Belt	9–16	56.43	143	23.90	14.28	170
8. 2., 11. 3.						
Little Belt	8–16	55.67	260	23.32	13.92	320
24. 1., 13. 2.						
N. Belts	10–16	56.25	1479	24.44	14.50	1284
18. 8.–16. 12.						
Aarhus Bay	12–16	56.49	141	24.28	14.85	39
10. 9.						
S. Great Belt	8–16	56.26	86	24.16	13.98	51
11. 3.						
S. Great Belt	5–10	56.25	163	24.56	14.15	93
4. 7.						
S. Great Belt	8–15	56.20	270	25.12	14.52	134
16. 9.–2. 10.						
Little Belt	10–17	56.26	97	24.59	14.25	96
18. 11.						
E. of Bornholm	11–18	55.91	93	24.28	14.22	101

2. Young herring in the southern Kattegat, the Belts, and the Baltic

In the southern Kattegat the fishing for small herring is insignificant. Four samples were investigated in July—November. According to the racial characters the herring taken here were autumn spawners. In a sample from 31. July the racial characters were rather similar to those of the small herring found in such great abundance in the northern Kattegat in May—December, but no doubt they were mixed with young Kobbergrund herring; the length of the herring was about 11 cm. The other three samples consisted exclusively of Kobbergrund herring. The length of these fish was about 10 cm. in July and 13—15 cm. in October—November.

In the north-western part of the Belt Sea, the Aarhus Bay, the small herring caught in the first quarter of the year were about 8—18 cm. long (comp. Table 58). The racial investigations (Table 57) show that the main part, over 13 cm. long, were Belt Sea spring spawners, whereas the smaller ones show the racial characters of the Atlanto-Scandian spring spawners or the Kattegat winter herring which at this time were plentiful in the Skagerak and northern Kattegat.

In the northern Great Belt the herring in two samples from February—March were about 12—13 cm. long. Their V.S. of 56.43 might indicate that they were North Sea autumn spawners or Kobbergrund herring. The V.P. of 23.90 is in accordance with a North Sea origin but exclude the Kobbergrund herring. The K_2 of 14.28 exclude the North Sea herring but might accord with the Kobbergrund herring. Actually they must be a mixture of the same two races of spring spawners found in the Aarhus Bay samples.

The young herring of about 13 cm. length found in March in the southern part of Great Belt were also a mixture of these two races.

Table 58. Length distribution (‰) of young herring in Danish commercial trawl catches from the northern Belt Sea in 1957
A = Aarhus Bay, F = north of Fyn, G = northern Great Belt

Date	9. 1.–5. 3.	18. 2., 11. 3.	27. 3.	27. 3., 15. 4.	12. 8.	21. 8.–28. 8.	10. 9.	23. 9.–21. 10.	5. 11.–16. 12.
Region	A	G	A	A, F	F	A, F	A	A, F	A, F, G
Depth, m.	14–25	16–30	16	16–19	20	16–23	13	10–23	14–29
No. of samples	4	2	1	2	1	3	1	3	7
cm. 4	—	—	—	5	14	—	—	—	—
5	4	—	—	36	5	—	—	—	—
6	—	—	—	5	14	—	—	—	3
7	—	—	—	—	28	—	—	—	14
8	48	9	10	—	135	2	—	—	28
9	50	14	37	10	285	23	—	—	41
10	59	75	16	38	332	64	—	9	61
11	132	197	21	53	150	214	—	43	135
12	168	272	21	81	37	536	23	145	226
13	210	260	58	185	—	156	230	501	358
14	162	124	120	272	—	6	536	279	189
15	80	40	183	183	—	—	200	24	32
16	50	12	200	96	—	—	11	—	12
17	29	—	162	23	—	—	—	—	1
18	8	—	141	13	—	—	—	—	—
19	2	—	26	—	—	—	—	—	—
20	—	—	5	—	—	—	—	—	—
Total	1002	1003	1000	1000	1000	1001	1000	1001	1000
Number invest.	524	346	191	394	214	890	265	590	1406

Table 59. Racial characters of herring caught for human consumption in the Skagerak, Kattegat, Belts, and Baltic in 1957
P = Pound net, T = Trawl

Locality	Date	Gear	Maturity	Length, cm. Mean	Length, cm. Range	Winter-rings	V.S. Mean	V.S. No.	V.P. Mean	K_2 Mean	K_2 No.
N.W. of the Scaw	30. 1.	T	I, II	22	20–24	1 (2)	56.61	64	24.00	14.36	55
N. of Hirtshals	1. 4.	T	I, II	22	18–25	1 (2)	56.44	174	24.01	14.48	154
N. of Hirtshals	1. 4.	T	IV, V, (VI)	28	23–32	2–7	55.87	142	23.42	14.34	140
N. of Hirtshals	1. 4.	T	VII, VIII	30	25–32	4–11	56.42	67	23.78	14.67	66
W.N.W. of the Scaw	14. 5.	T	II, III	22	20–25	1, 2	56.06	130	24.22	14.32	88
North Seeland	7. 5.	P	II, III, IV	22	18–27	2 (3)	55.75	154	23.87	14.07	137
North Seeland	7. 5.	P	V, VI, VII	24	20–27	2, 3	56.12	43	23.70	14.20	41
At Samsø	2. 10., 16. 10.	T	I, II	20	17–22	1 (2)	56.16	255	23.72	14.25	250
S. of Lolland	21. 11.	P	c. II	24	20–26	2	55.70	79	24.70	14.31	75
E. of Bornholm	20. 8.	T	I	19	17–22	1	55.33	27	24.33	13.39	23
E. of Bornholm	20. 8.	T	II	22	18–29	2–8	55.32	161	23.98	13.62	149
E. of Bornholm	20. 8.	T	III, IV	23	20–26	2–5	55.41	54	23.67	13.98	54
E. of Bornholm	20. 8.	T	V, VI, VII	23	19–27	2–7	55.47	78	23.99	13.90	78

Figures for maturities or winter-rings in brackets denote small admixtures.

In the Little Belt the herring in samples from the first quarter of the year were unmixed southern Belt Sea spring spawners.

In August the herring caught in the northern Belt Sea were about 10—12 cm., and they increased to about 14—15 cm. in December. Some smaller herring constituted a portion of a few of the samples in November—December but no racial analysis was made. These fish may have been local spring/summer spawners. The bulk of the herring were Kobbergrund herring. In one sample from the Aarhus Bay in September the herring were autumn spawners from the west coast of Jutland possibly mixed with other North Sea autumn spawners.

In the northern Great Belt some small herring of about 8 cm. were found in July. Their racial characters showed that they were pure Kobbergrund herring. The K_2 is a little too low but this may be ascribed to the uncertainty of counting this character on such small herring. In September to October the herring here were Kobbergrund herring or coastal winter spawners from the northern Kattegat.

In the Little Belt the same herring as these were found in a sample from November. They are seldom encountered in this region.

At Bornholm a trawl fishery for small herring has developed in recent years. A sample from E. of Bornholm in January showed the unexpected result that these fish might belong to the group of coastal autumn spawners from the southern Kattegat.

3. Herring fished for human consumption

The length, age, maturity, and racial characters in the samples are shown in Table 59. It is seen that the 1-ringers from Skagerak in January may be assumed to be Downs herring. The K_2 is too low but the sample is small. The 1-ringers fished off Hirtshals on 1. April seem to have been from the Dogger or Gut, the maturing, including some few mature fish, were Kattegat coastal spring spawners. The spent and recovering spents of about the same length were Dogger Bank herring.

A sample from off the Scaw in May consisted of immature Kattegat coastal late-autumn spawners.

A sample from N. of Seeland in May contained partly immature Belt Sea summer spawners, partly mature and spents of the Kattegat—northern Belt Sea coastal spring herring. Two samples from October taken N. of Fyn and E. of Samsø were immature fish of the same race. South of Lolland a large fishery for immature herring of the Kattegat coastal autumn spawners took place in November.

At Bornholm a sample from August contained herring of all maturities. The mature or just spent fish showed the same racial characters as found in previous years for the autumn spawners of this area, and those of maturities III—IV were mostly of the same race. It is worth noting that they constituted two-thirds of the sample, which is in accordance with the results of the previous years: that the stock of autumn spawners is recovering.

The immature herring must have their home in the central or inner Baltic but the racial characters of the races there are not suffciently known to decide where they belong.

Aage J. C. Jensen

Sardine

COMMERCIAL FISH

Sardine

La Sardine de la Côte du Portugal en 1957

(Figures 1–4; Tableaux 1–5)

En poursuivant les recherches sur la sardine des côtes portugaises, nous avons étudié, en 1957, 22.400 exemplaires de Leixoes, 22.213 de Lisbonne et 20.806 de Portimão. Les échantillons ont été recueillis tous les jours de pêche et pendant toute l'année, avec l'exception des mois de Février et Mars (Lisbonne et Portimão) et aussi d'Avril pour Leixoes. Au delà de ces échantillons qui ont fourni exclusivement des informations sur la taille de la sardine, nous avons observé, à Lisbonne (siège de l'Institut de Biologie Maritime), 30 échantillons hebdomadaires comprenant en tout 3960 poissons, étudiés sous l'aspect de la taille, de la croissance, de l'âge, de la graisse, de la maturité sexuelle, du poids et de la moyenne vertébrale.

Taille

La longueur adoptée a été, comme dans les années antérieures, celle comprise entre le bout du museau et la fourche de la nageoire caudale et correspond à peu près à 90% de la longueur totale.

La Figure 1 montre, sous forme de graphiques, la distribution des fréquences des tailles groupées par mois et par classes de taille de 0,5 cm., exprimées en millièmes du nombre totale de sardines observées à Leixoes, Lisbonne et Portimão.

Les sardines de la classe 0 d'âge (génération de 1957) ont apparu pour la première fois dans le produit de la pêche, à Lisbonne et à Portimão, dans le mois de Mai, représentées par un petit nombre d'exemplaires; à Leixoes, cette classe est déjà représentée dans les échantillons d'Août, mais seulement en Septembre le nombre d'individus est assez considérable. La plupart des sardines pêcheés à Lisbonne et à Portimão pendant 1957

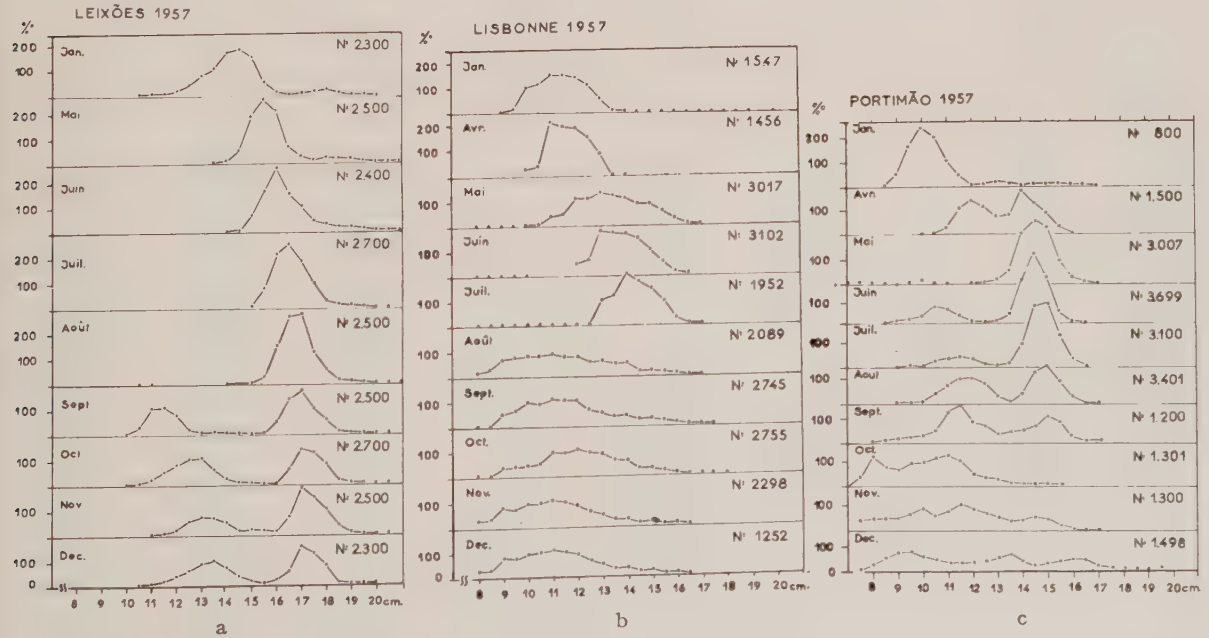


Figure 1 a–c.

Tableau 1. Fréquences des tailles en $^0/_{00}$ du nombre total d'exemplaires observés en chaque mois (1957)

L = taille en classes de demi-centimètre N = nombre total d'exemplaires observés

Leixoes

L	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
10,0	—	—	—	—	—	—	—	—	3	1	—	—
10,5	3	—	—	—	—	—	—	2	39	10	—	1
11,0	9	—	—	—	—	—	—	3	112	25	2	11
11,5	13	—	—	—	—	—	—	—	113	54	13	22
12,0	23	—	—	—	—	—	—	—	81	84	26	47
12,5	49	—	—	—	—	—	—	—	24	104	58	64
13,0	84	—	—	—	—	—	—	—	10	110	78	93
13,5	113	—	—	—	2	—	—	—	15	67	74	102
14,0	176	—	—	—	13	1	—	2	8	29	56	78
14,5	188	—	—	—	58	7	—	—	7	14	22	43
15,0	159	—	—	—	198	73	13	3	4	12	23	24
15,5	58	—	—	—	267	173	87	31	5	4	22	17
16,0	20	—	—	—	227	263	221	156	53	10	20	28
16,5	6	—	—	—	73	161	259	271	144	68	78	60
17,0	15	—	—	—	35	112	198	282	178	144	199	162
17,5	19	—	—	—	20	52	101	131	105	133	152	132
18,0	29	—	—	—	30	41	44	61	63	88	106	85
18,5	17	—	—	—	25	39	29	22	16	22	41	17
19,0	12	—	—	—	24	39	24	16	12	12	14	10
19,5	6	—	—	—	18	21	14	12	5	5	9	3
20,0	1	—	—	—	6	12	6	5	2	2	3	1
20,5	—	—	—	—	3	5	4	2	1	2	4	—
21,0	—	—	—	—	1	1	—	1	—	—	—	—
N	2300	—	—	—	2500	2400	2700	2500	2500	2700	2500	2300

Lisbonne

L	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
8,0	—	—	—	—	1	2	1	22	3	4	—	33
8,5	—	—	—	—	1	2	1	31	8	3	—	35
9,0	2	—	—	—	1	2	9	74	51	43	17	82
9,5	21	—	—	—	1	3	9	79	66	45	17	78
10,0	109	—	—	34	3	1	12	87	100	50	46	95
10,5	122	—	—	45	2	—	6	87	98	53	44	100
11,0	158	—	—	223	41	—	7	98	110	101	117	113
11,5	154	—	—	207	50	—	2	83	107	99	118	101
12,0	150	—	—	203	115	51	2	85	107	116	134	92
12,5	122	—	—	165	114	64	4	64	70	106	117	67
13,0	67	—	—	102	137	184	117	65	59	99	97	52
13,5	25	—	—	11	128	176	124	53	45	72	69	34
14,0	19	—	—	10	117	170	214	55	48	65	58	36
14,5	10	—	—	—	93	152	185	34	31	38	50	22
15,0	13	—	—	—	89	105	155	30	34	37	42	25
15,5	8	—	—	—	61	59	101	22	24	26	23	15
16,0	10	—	—	—	30	19	36	19	19	17	18	18
16,5	4	—	—	—	12	10	14	7	12	7	13	2
17,0	1	—	—	—	4	—	1	5	7	12	10	—
17,5	1	—	—	—	—	—	—	—	1	5	7	—
18,0	1	—	—	—	—	—	—	—	—	2	3	—
18,5	1	—	—	—	—	—	—	—	—	—	—	—
19,0	1	—	—	—	—	—	—	—	—	—	—	—
19,5	—	—	—	—	—	—	—	—	—	—	—	—
20,0	1	—	—	—	—	—	—	—	—	—	—	—
20,5	—	—	—	—	—	—	—	—	—	—	—	—
21,0	—	—	—	—	—	—	—	—	—	—	—	—
N	1547	—	—	1456	3017	3102	1952	2089	2745	2755	2298	1252

Tableau 1 (suite)

Portimão

L	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
6,5	—	—	—	—	1	—	—	—	—	—	—	—
7,0	—	—	—	—	9	—	—	—	—	5	13	1
7,5	—	—	—	—	12	—	—	—	—	39	40	12
8,0	—	—	—	—	8	—	—	—	7	121	45	27
8,5	13	—	—	—	4	2	—	—	11	82	49	50
9,0	53	—	—	—	1	9	1	2	17	69	48	79
9,5	169	—	—	—	6	15	4	4	21	95	64	80
10,0	245	—	—	1	14	37	13	16	25	97	85	63
10,5	214	—	—	4	9	70	27	46	52	113	55	59
11,0	115	—	—	29	2	60	36	79	126	123	73	43
11,5	51	—	—	106	—	35	48	103	154	101	106	42
12,0	16	—	—	142	1	10	39	110	85	50	84	37
12,5	16	—	—	117	10	3	23	94	74	35	70	46
13,0	25	—	—	76	20	11	9	41	38	29	55	64
13,5	20	—	—	81	56	37	15	18	43	12	41	78
14,0	10	—	—	179	203	174	94	46	51	4	42	48
14,5	11	—	—	132	263	283	253	130	65	8	52	24
15,0	14	—	—	91	232	196	261	161	105	7	48	35
15,5	16	—	—	35	97	49	133	97	85	10	20	45
16,0	4	—	—	7	38	8	37	39	27	—	6	53
16,5	6	—	—	—	13	1	7	10	9	—	3	51
17,0	1	—	—	—	1	—	—	4	5	—	1	36
17,5	1	—	—	—	—	—	—	—	—	—	—	15
18,0	—	—	—	—	—	—	—	—	—	—	—	7
18,5	—	—	—	—	—	—	—	—	—	—	—	3
19,0	—	—	—	—	—	—	—	—	—	—	—	1
19,5	—	—	—	—	—	—	—	—	—	—	—	1
20,0	—	—	—	—	—	—	—	—	—	—	—	—
20,5	—	—	—	—	—	—	—	—	—	—	—	—
21,0	—	—	—	—	—	—	—	—	—	—	—	—
N	800	—	—	1500	3007	3699	3100	3401	1200	1301	1300	1498

Tableau 2. Poids moyens annuels des sardines de Lisbonne, en 1957

Longueur, cm.	Poids total, g.	Nombre d'individus	Poids moyen annuel, g.
8,5	44	8	5,5
9,0	165	24	7,2
9,5	674	86	7,8
10,0	2068	225	9,2
10,5	3374	314	10,7
11,0	4401	344	12,8
11,5	5105	355	14,4
12,0	6550	395	16,6
12,5	7981	418	19,1
13,0	8692	396	22,0
13,5	7219	290	24,9
14,0	5436	187	29,1
14,5	8797	257	34,2
15,0	11512	296	38,9
15,5	9481	222	42,7
16,0	3921	81	48,4
16,5	1672	32	52,3
17,0	558	10	55,8
17,5	356	6	59,3
18,0	395	6	65,8
18,5	212	3	70,7
19,0	172	2	86,0
19,5	83	1	83,0
20,0	94	1	94,0

Tableau 3. Longueur moyenne des mâles et des femelles de Lisbonne, en chaque mois, en 1957

L = longueur moyenne en mm. N = nombre d'exemplaires.

		Mâles	Femelles
Janvier	L	115	120
	N	116	184
Février		—	—
Mars		—	—
Avril	L	125	121
	N	122	78
Mai	L	131	135
	N	288	212
Juin	L	150	155
	N	92	108
Juillet	L	150	151
	N	171	129
Août	L	132	136
	N	54	46
Septembre	L	148	136
	N	48	52
Octobre	L	112	120
	N	190	110
Novembre	L	111	116
	N	153	146
Décembre	L	109	110
	N	55	45

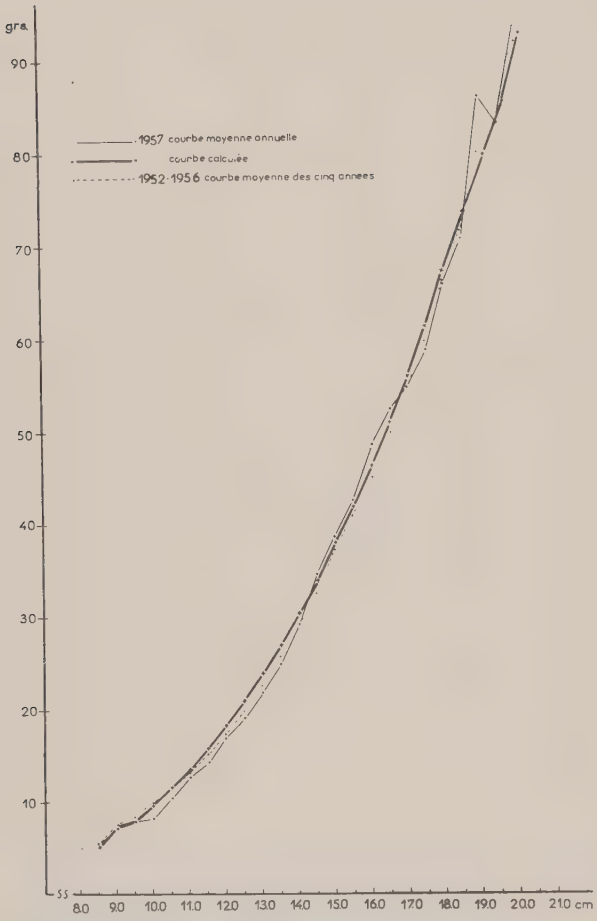


Figure 2.

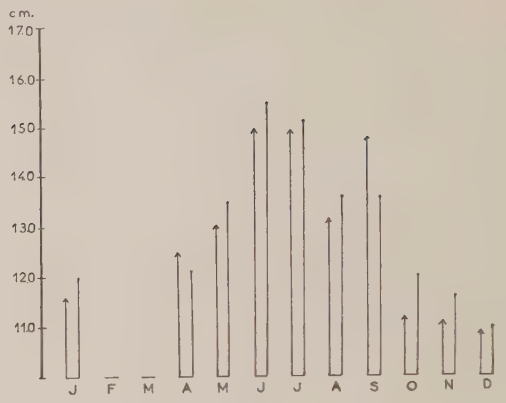


Figure 3.

appartient à la génération de cette année (classe 0) tandis qu'à Leixoes ce sont les sardines plus âgées qui ont prédominé (classes d'âge I et II, spécialement).

L'évolution de la croissance des diverses classes d'âge est très nette et individualisée dans le graphique correspondant à Leixoes et très irrégulière dans celui de Portimão. Cela peut être le résultat d'une plus grande hétérogénéité des stocks de cette région, qui réunissent, très possiblement, les produits de diverses pontes réalisées dans la même époque de reproduction, mais assez séparées les unes des autres.

Dans le graphique de la Figure 2 nous avons représenté la courbe moyenne annuelle de 1957 ainsi que celle de l'ensemble des cinq années antérieures à 1952—1956. Nous a vons tracé aussi la courbe calculée, suivant la formule $W = -2{,}2 + 0{,}01182\ L^3$ déterminée dans un travail antérieur (Oliveira et Pinto, 1957, Rev. Fac. Ci. Lisbonne, 2ª sér., C, **6**: 5—14).

Les trois courbes se ressemblent beaucoup, ce qui est un indice de la régularité d'évolution pondérale dans les diverses années et aussi de la valeur représentative de la formule proposée.

Maturité et graisse

Les données obtenues à Lisbonne ne diffèrent pas sensiblement de celles, déjà citées, des années précédentes. Les sardines femelles en pleine ponte (ovules gonflés, gélatineux et semi-transparents), sont toujours très rares dans le produit des pêches industrielles, ce qui doit être le résultat de déplacements des sardines mûres pendant la période de réproduction.

Le nombre des femelles dépasse celui des mâles dans les mois de Janvier, Juin et Septembre, mais seulement en Janvier les valeurs sont significatives. Dans les autres mois ce sont les mâles qui prédominent toujours en nombre d'exemplaires.

Tableau 4. Formule vertébrale annuelle des sardines de Lisbonne, en 1957

Nombre de vertèbres	Nombre d'exemplaires												Total
50	27	—	—	18	51	26	31	31	26	30	38	27	305
51	209	—	—	136	343	215	254	207	124	200	191	128	2007
52	63	—	—	44	105	57	109	58	49	69	69	45	668
53	1	—	—	2	1	2	6	4	1	1	2	—	20
Total	300	—	—	200	500	300	400	300	200	300	300	200	3000

Dans le graphique de la Figure 3 on a représenté les tailles moyennes mensuelles des mâles et des femelles. À l'exception des mois d'Avril et Septembre, les femelles sont toujours plus grandes.

Moyenne vertébrale

Les observations ont porté sur 3000 sardines de Lisbonne. La moyenne vertébrale annuelle a été de 51,13, avec une Fl. M. de ±0,036. Les moyennes vertébrales par échantillon ont varié entre 51,01 et 51,30.

Dans le graphique de la Figure 4 on a représenté les moyennes vertébrales par échantillon, des sardines de Lisbonne, dans les années 1952—1957, ce qui correspond à une totalité de 28.504 exemplaires. Les valeurs précédées d'un M, représentent les moyennes annuelles, lesquelles ont été de 51,22 en 1952 et en 1953; de 51,17 en 1954; de 51,14 en 1955; de 51,11 en 1956 et de 51,13 en 1957, comme nous avons déjà cité. Il nous semble, donc qu'il y a eu une diminution des valeurs, dans les dernières années, ce qui nécessite, néanmoins, une appréciation critique au point de vue de sa véritable signification statistique et suggère aussi la nécessité d'obtenir, dans les années prochaines, des informations océanographiques sûres des conditions de ponte et dévelopment de la sardine des côtes portugaises.

Tableau 5. Formule vertébrale de l'ensemble des six années

Nombre de vertèbres	1952	1953	1954	1955	1956	1957	Total
	Nombre d'exemplaires						
49	2	1	5	1	1	—	10
50	416	316	635	463	352	305	2487
51	3459	2913	4824	3300	2242	2007	18745
52	1551	1257	1808	1117	700	668	7101
53	45	27	37	18	13	20	160
54	—	—	1	—	—	—	1
Total ..	5473	4514	7310	4899	3308	3000	28504

La moyenne vertébrale de l'ensemble a été de 51,173, avec une Fl. M. = ±0,012.

J. S. Pinto et I. F. Barraca

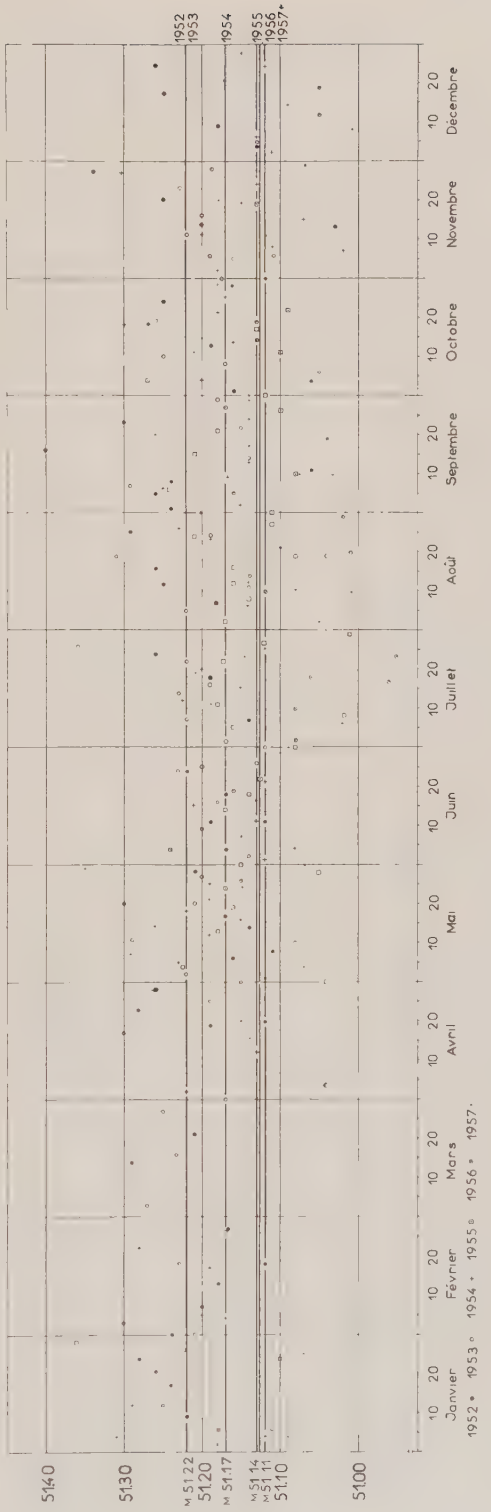


Figure 4.

Sprat

Sprat in the Danish Catches

(Tables 6–7)

Length distribution

The length distribution of the sprat caught in trawls with cod-end meshes of 11—18 mm. by the Danish fishery for small herring are shown in Table 6. In the Skagerak and northern Kattegat the 11 mm. mesh has been most used, while in the southern Kattegat, Belts, Baltic, and Limfjord mostly the 13 and 14 mm. meshes. The nets of 18 mm. mesh size used in the northern regions catch larger sprat than the nets with smaller mesh size, mostly because the larger mesh is used on greater depths where the sprat are bigger.

Some sprat over 10 cm. long have been sorted out from some of the catches and sold separately for preservation for human consumption. For the Skagerak and northern Kattegat this portion has also been investigated when samples from such catches have been sent to the laboratory, and therefore the length distribution in Table 6 gives the correct length of the sprat in the catches in these regions. In the southern Kattegat, the Limfjord, and the Baltic no sprat have been sorted beforehand from the catches investigated. In the Belts such a sorting of larger sprat has been made in a great many of the catches. The portion sorted out from the catch for preservation has also been investigated for some of these catches and added to the other portion, but in most cases we have no knowledge of the length of these sprat which are used for human consumption. The figures shown in Table 6 are therefore not fully correct for the Belts, but the error is only small. On an average 8% of the total weight of the catches from the Belts were sorted out from the catch beforehand but in the cases where the greatest amount of sprat were sorted out the lengths of the fish were over 10 cm.

In the Skagerak and northern Kattegat the length was as usual very much lower at depths below 40 or 60 m. than at greater depths. At the latter depths the sprat are mostly scarcer than in more shallow waters.

In the first quarter of the year sprat under 10 cm. length constituted about 30% of the total number fished in depths less than 43 m., but later on there were very few fish of this size in the trawl catches analysed. Probably they were somewhat more frequent in the trawl catches in the first half of the summer than our figures show, as some small sprat were present in a sample from the pound-net fishery in the northern Kattegat taken on 6. June (cf. Table 6).

The scarcity of small sprat in the Danish catches in the second half of the year has been observed also in several other years, e.g., 1952, 1953, and 1955. This scarcity is due to the fact that the one-year-old sprat in this season are mostly over 10 cm. in length, and that the number of the 0-group which in the fourth quarter is about 7 cm. long is very small. They belong to one of the frequently poor year-classes.

In the third quarter of 1956 the sprat originating from that year were very numerous; in the samples from the fourth quarter, however, they were very rare.

No data of catch per fishing effort are available but there is some evidence for the large sprat being also less frequent in the second half of the year than is the normal case. In the catches taken in the fourth quarter of the year the sprat constituted by weight 5% of the fish sold for industrial purposes, as against 13% in 1956; the extraordinary abundance of young herring observed in the summer and autumn of 1957 must naturally have diminished the proportion of sprat contained in the catches.

A factor which to a great extent may have influenced the abundance of both small and large sprat present in the south-eastern Skagerak and northern Kattegat is the transport by the currents of sprat from this region to the Belt Sea, where this race in 1957 was observed in extraordinary great quantities (see below).

In the southern Kattegat the length distribution was almost the same as that in the northern area (see Table 6).

In the northern Belt Sea (N. of the island of Sprogø in Great Belt and N. of Fyn) two groups of sprat were encountered in the first half of the year, namely, one-year-old fish of about 7—9 cm. in length and a less numerous group of 12—15 cm. In the third quarter of the year the 1956 year-class was not present in the samples examined, but in the fourth quarter this class was plentiful, and the length had increased to about 9 cm.

The length of the 7—9 cm. group during the first half of the year is somewhat greater than normally for the $^3/_4$—1 year old sprat in this region and is similar to the length of sprat of this age occurring in the south-eastern Skagerak and northern Kattegat.

The racial characters show that both length groups in this region in 1957 were remarkably mixed with sprat of the race belonging to the south-eastern Skagerak and northern Kattegat.

Table 6. Length composition (‰) of sprat in the different quarters of the year 1957

Total length to cm. below. All catches taken by trawl except the one in June (pound-net)

	S.E. Skagerak and N. Kattegat						
	1st quarter		June	2nd quarter		4th quarter	
Depth, m.	26—43	60	c. 5	35—50	60	26—38	60
cm.							
5	—	—	—	—	5	—	—
6	4	—	269	—	—	—	—
7	49	3	226	—	—	11	—
8	171	3	161	—	—	12	—
9	63	—	215	—	23	39	—
10	47	6	129	15	28	72	—
11	115	27	—	61	9	150	—
12	264	205	—	188	88	294	23
13	227	479	—	411	321	277	70
14	39	139	—	178	218	88	186
15	17	80	—	132	162	45	349
16	2	53	—	15	111	11	302
17	—	6	—	—	37	—	70
Total	998	1,001	1,000	1,000	1,002	999	1,000
Number examined	462	361	93	197	215	180	43
Number of samples	6	8	1	2	13	12	8

	Limfjord	S. Kattegat	Northern Belt Sea				S. Little Belt	
	1. quart.	3.–4. quart.	1. quart.	2. quart.	3. quart.	4. quart.	1. quart.	4. quart.
Depth, m.	9—20	9—23	14—36	18	12—23	10—34	30—38	14—34
cm.								
3	—	—	—	—	—	2	—	—
4	—	—	1	—	—	—	—	—
5	2	—	11	—	—	6	4	18
6	85	—	115	12	—	25	61	137
7	512	—	276	36	—	86	214	210
8	159	—	239	88	—	265	383	225
9	10	39	103	190	6	285	254	244
10	26	78	52	108	152	68	67	23
11	92	13	11	81	630	59	12	11
12	108	117	55	105	173	142	4	80
13	6	325	103	182	34	57	2	34
14	—	325	30	141	5	4	1	12
15	—	91	3	52	—	—	—	4
16	—	13	1	4	—	—	—	—
Total	1,000	1,001	1,000	999	1,001	999	1,002	998
Number examined	1,798	77	3,031	248	386	453	2,353	262
Number of samples	5	4	8	1	6	9	3	3

The racial characters

In each of the regions the differences between the mean values of the individual samples are insignificant. In Table 7 the range has been shown for the two regions where most samples have been examined. Actually, some of the differences between these means must be attributed to the relatively small samples consisting of 50 to 150 specimens. The mean values were practically identical in small and big sprat. On the Norwegian coast the mean lengths of the individual samples of a similar size show much greater differences, and only one-third lies within the range of the samples from the south-eastern Skagerak and northern Kattegat where the Danish fishery for sprat is operated. Therefore, only one-third of the sprat present on the Norwegian coast can possibly belong to the same stock as that in the south-eastern Skagerak (see Ann. Biol., 13).

In the southern Kattegat the mean values of the racial characters of the sprat examined in 1957 tally with those found in the south-eastern Skagerak. The sprat taken in the southern Kattegat most often belong to the race found in the south-eastern Skagerak but may be mixed with the Belt Sea races.

Table 7. Racial characters of sprat in 1957

The figures below the means of V.S., V.P., and K_2 (number of fish in brackets) show the range of the individual samples

	Months	Number of samples	Length, cm.	V.S.	V.P.	K_2
The Skagerak and northern Kattegat	Febr.–June	10	10—17	47.99 (932) 47.86—48.06	17.91 17.82—17.97	11.89 (651) 11.73—11.94
	October	2	11—17	47.97 (165) 47.93—48.01	17.90 17.90—17.92	11.84 (167) 11.82—11.85
The Limfjord	March	2	6—12	47.40 (169)	17.57	11.79 (402)
S. Kattegat	May–Oct.	2	12—15	47.84 (143)	17.98	11.79 (139)
Round Samsø — N. Great Belt	Febr.–Nov.	11	5—16	47.80 (1266) 47.61—47.93	17.90 17.79—18.24	11.83 (1488) 11.67—11.93
S. Little Belt	March–Nov.	2	6—14	47.66 (89)	17.68	11.78 (304)
E. of Bornholm	March	1	9—12	— —	—	11.46 (198)
Oder Bank	May	1	8—13	47.70 (207)	17.90	11.57 (83)
E. of Bornholm	November	1	9—13	47.62 (114)	18.00	11.26 (119)

In the northern part of the Belt Sea the average value of V.S. for all samples in 1957 was within the range of the averages for the previous seasons for this region and below the averages for the Danish samples from the Skagerak and the northern Kattegat; the average of K_2 for all samples in 1957 was higher than the averages for the Belts in the previous seasons and about the average of all samples in the Skagerak and northern Kattegat. The combined V. S. and K_2 data for about half of the individual samples from the northern Belt Sea in 1957 (when drawn into a V. S./K_2 diagram) lie within the values of the Danish samples from the Skagerak and northern Kattegat. The extraordinary occurrence of these sprat in the Belt Sea in 1957 may explain the relative scarcity of sprat in the northern region. In this connexion attention should be drawn to the high bottom salinity at "Halsskov Rev" lightvessel in February and during the period July–September 1957 which may indicate a strong influx of salt water (see Table 1, p. 89).

The southern Little Belt and the neighbouring parts of the western Baltic are populated by a pure Belt Sea race of sprat which is rarely mixed very much with sprat of other racial characters and the V. S. and K_2 data in the two samples from the southern Little Belt examined in 1957, fit very well with those of previous years.

The samples from the Bornholm region show in 1957 values for V. S. which are considerably lower than those of the few previous samples from this region, and the V. S. and K_2 data are similar to those in samples from previous years from the Belts and western Baltic, except in one sample from November where the K_2 is very low.

It may seem that an inflow of sprat took place in 1957 from the Belt Sea to the Bornholm region, corresponding to the unusual inflow from the Kattegat to the Belt Sea.

It is interesting that the surface salinity at Christiansø, to the north-east of Bornholm, was about 1‰ above normal during the greatest part of 1957, a fact which may indicate an eastward displacement in the upper water layer in this year.

Aage J. C. Jensen

Polish Investigations on Baltic Sprat in 1957

(Tables 8–9)

The samples were taken from bottom trawl catches only.

The age composition of the catches in different areas of the southern Baltic is given in Table 8.

During the whole year the very strong 1955 year-class dominated the catches taken in all areas of the southern Baltic.

The 1956 year-class was very poor. This was probably caused by unfavourable thermic conditions during the spawning period of 1956.

In autumn 1957, the new brood (hatched in the spring and summer of 1957) began to appear in the commercial stock. This process, most intensive in the Gulf of Gdańsk, was observed at the same time in the whole southern Baltic.

Growth and fat content in relation to temperature

In recent years the growth and fat content of the sprat occurring in the Gulf of Gdańsk have changed, as shown in Table 9.

Table 8.

Year-classes	Gulf of Gdańsk Spring Winter	Gulf of Gdańsk Spring and summer	Gulf of Gdańsk Autumn	Southern part of the Bornholm area Spring Winter	Southern part of the Bornholm area Spring and summer	Southern part of the Bornholm area Autumn	Pomerania Bay Spring Winter	Pomerania Bay Spring and summer	Pomerania Bay Autumn
1951	37	1	—	57	1	—	—	—	—
1952	54	2	2	52	6	—	—	—	—
1953	185	5	12	168	35	24	—	—	20
1954	184	9	52	145	84	62	—	—	80
1955	536	983	755	578	873	847	—	1,000	780
1956	4	—	33	—	1	—	—	—	60
1957	—	—	146	—	—	67	—	—	60
Total	1,000	1,000	1,000	1,000	1,000	1,000	—	1,000	1,000
Number of fish	5,169	2,544	2,488	1,257	2,001	894	—	200	506

The length increases and the fat content in general varied with summer water temperature on a parallel line, with the exception ot the t^1 increase (influenced essentially at the reproduction time of the fish), and the increase of t^4 (which could be explained by errors in age determinations by means of the otoliths).

In 1957 the t^2 and t^3 increases were extraordinarily high, probably owing to the faster growth of the fish to "compensate" for the slow growth ot the preceding year.

Table 9.

Year	Increase in length (cm.) t^1	t^2	t^3	t^4	Maximum fat content	Mean temperature (°C.) in Aug.–Oct.
1954	8.9	2.0	0.5	0.3	13.5	15.0
1955	7.7	2.3	0.8	0.8	19.1	19.7
1956	6.6	1.7	0.3	0.7	10.9	14.4
1957	no data	4.3	1.3	0.2	17.8	15.1

J. Elwertowski

Scombriform Fish

The Stock of Mackerel in the North Sea in 1956

(Figures 1–2; Table 1)

During four cruises with F.R.S. "Anton Dohrn" in the North Sea in 1956, a study was carried out by ERDAL AKER on the stock of the mackerel as to size, age, sex, and maturity. The material was obtained by trawling in February–March in the northern North Sea; in June–July and August to September in the central and southern North Sea; and in October in the central and northern parts of the North Sea. 12,000 fish were measured, and age determinations by means of the otoliths were made on 2,000 fish, 11–43 cm. in length. The otoliths were carefully cleaned, dried, and preserved in small tubes with Methylbenzoat which lets the annual zones appear with clearness and makes most of them well readable (Fig. 2). The average lengths of age-groups I–IX are given in Table 1.

Maturity occurs at the end of the third year of life in both sexes when the fish has attained a length of at least 30 cm.; a few males only ripen at a lower length. After the fish has reached maturity the annual growth increment falls to about 1 cm. or

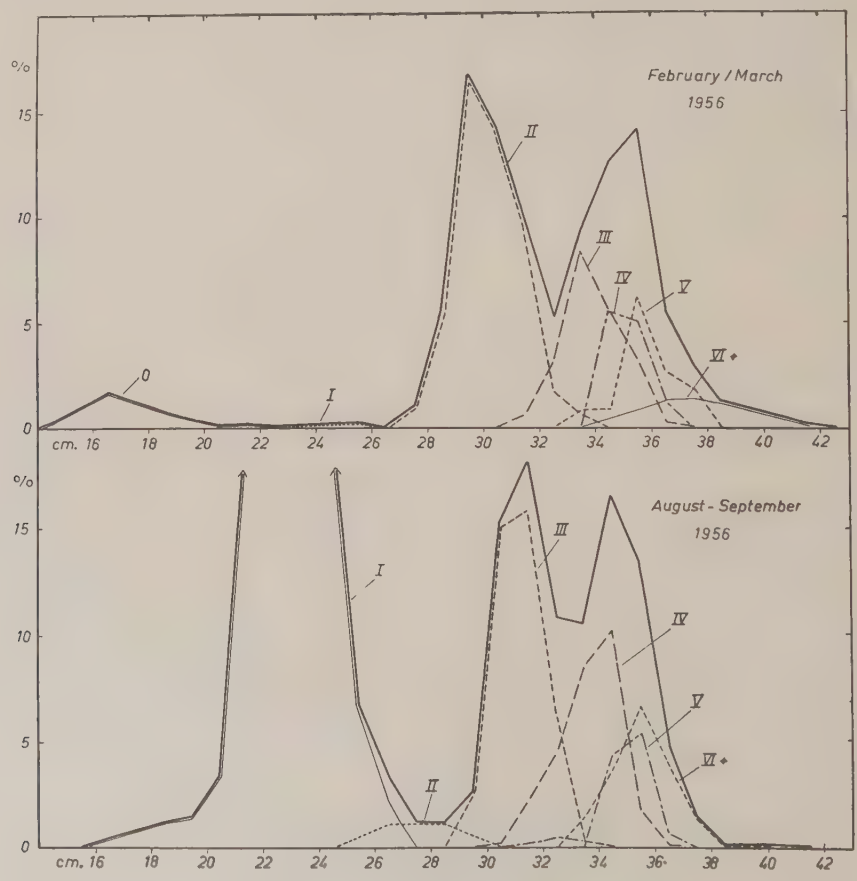


Figure 1. Length distribution of different age-groups of the mackerel caught by the R/V "Anton Dohrn" in February/March in the northern North Sea, and in August/September in the central and southern North Sea. (Number of fish 26–43 cm. long = 100).

(a) 17 cm., in the second year. (b) 24 cm., in the second year. (c) 29 cm., in the third year. (d) 32 cm., in the fourth year. (e) 35 cm., in the sixth year.

Figure 2. Otoliths of mackerel, August/September 1956.

Table 1. Mackerel, average length of age-groups, June/July 1956

Age-group	I	II	III	IV	V	VI	VII	VIII	IX+
Average length, cm.	21.1	26.3	30.6	33.8	35.0	35.7	36.2	38.2	39.5
Length range, cm.	16—26	24—29	27—34	30—36	31—36	33—37	33—39	36—40	35—43
Number of fish	1,012	39	399	152	93	88	42	18	6

less. It is consequently only possible to recognize the age-groups I to III as separated peaks in the length distribution of the catches taken by "Anton Dohrn", whereas the older age-groups concentrate in an extended and slowly sloping curve. These features are illustrated in Figure 1 as graphs of length and age distribution in February/March (northern North Sea) and August/September (central and southern North Sea). One year-old mackerel in the open sea are in general only caught by the trawl in small quantities. From Figure 1 it is apparent that the 1954 year-class (age-group I, resp. II) is almost absent, which suggests strong fluctuations.

In commercial catches from the North Sea, Kattegat, and western Baltic maxima at lengths of about 27 cm., 30 cm., and 33—36 cm. were found, representing the age-groups II, III, and older.

The fertility of the mackerel was estimated for 21 females at maturity stages IV—V. Counting of the eggs that are to be shed in the imminent spawning season is rather difficult as they do not ripen at the same time, and thus eggs of different sizes are found. The number of eggs varies between 374,000 and 957,000. The fertility was found to be proportional to the weight (g.) according to the equation

$$F = 1920 \times W$$

Although the weight is proportional to the cube of length, the relation between the number of eggs and the length of the fish (cm.) may approximately be expressed by the linear equation

$$F = 51{,}500\ (L - 22.2)$$

For example, the average number of eggs is 480,000 for a fish weighing 250 g. (31.5 cm.) and 768,000 for a fish of 400 g. (37.1 cm.).

As regards the spawning activity of the mackerel in the western Baltic, see the section Baltic-Belt Sea.

R. KÄNDLER

Salmon and Trout

England and Wales

Salmon and Sea Trout Experiments River Coquet, Northumberland

(Tables 1–3)

As in previous years, the grid type trap was installed in the River Coquet at Warkworth. The trap was in operation from 2. to 14. December 1956 in order to examine kelts for evidence of earlier tagging and fin-clipping, and to observe any migration that might occur at the end of the year, and during this period 235 sea trout kelts, 4 salmon kelts, 23 sea trout parr, and 16 salmon parr were caught. For the first ten days only 6 parr and 10 kelts were caught, but following heavy rain, a considerable amount of fresh water came down on the 11. and 12. and on these two days 15 sea trout parr, 12 salmon parr, 121 sea trout kelts, and 4 salmon kelts were trapped. The water level dropped on the 13. and only a few fish were caught.

Table 1. Recaptures from 4 salmon kelts and 75 sea trout kelts tagged at Warkworth, River Coquet, during December, 1956

Location of recapture	Species	Number
Northumberland coast	sea trout	4
River Tweed, Hallowstell fishery	sea trout	1
East coast of Denmark, off Hurup	sea trout	1

(In addition, one tag recovered on Amble beach off the mouth of the Coquet.)

Another heavy spate occurred on the 14. and the trap was broken.

None of the kelts caught showed any sign of having been tagged previously and as fin-clipping did not commence until the spring of 1956, none of the clipped fish, with the exception of whitling, could be expected to appear. A Lea tag was attached to 75 of the sea trout kelts and to the 4 salmon kelts released. Six of these trout kelts have since been recaptured, as shown in Table 1.

Table 2. Recaptures in 1957 (to 31. October) of Salmon tagged in previous years

Tagging data				Recapture data for 1957				
Year	Number tagged Smolts	Kelts	Place	Number and stage at which recaptured Smolts	Grilse	Salmon	Kelts	Place
1954	2,859		Warkworth			5		Northumberland coast
		37	Warkworth					
1955	4,000		Warkworth			43		Northumberland coast
			Warkworth			2		R. Coquet below Rothbury
			Warkworth			1		R. Coquet, tidal water
			Warkworth			1		R. Tweed, Whitesands
			Warkworth			1		R. Tay, below Perth
		72	Warkworth					
1956	3,587		Warkworth		8[1])			Northumberland coast
			Warkworth		2[1])			R. Coquet, Rothbury and below
		0	Warkworth					
1957	7,313		Warkworth					
		0	Warkworth					

[1]) Of these 10 grilse caught, three were reported as having the left pelvic fin clipped, the cut having healed with no regeneration. No confirmation of clipped fins was received in respect of the other seven caught by different fishermen.

Table 3. Recaptures in 1957 (to 31. October) of Sea Trout tagged in previous years

Tagging data				Recapture data for 1957			
Year	Number tagged		Place	Number and stage at which recaptured			Place
	Smolts	Kelts		Smolts	Sea trout	Kelts	
1954	5,022		Warkworth				
		1,021	Warkworth			1	R. Coquet, Felton
1955	6,031		Warkworth				
		1,342	Warkworth			3	Northumberland coast
			Warkworth			1	R. Coquet above Rothbury
			Warkworth			2	R. Coquet below Rothbury
			Warkworth			2	R. Coquet, Warkworth trap
			Warkworth			1	Filey Bay, Yorkshire coast
1956	3,890		Warkworth		1		Northumberland coast
			Warkworth		2		R. Coquet, Rothbury and below
		0	Warkworth				
1957	7,291		Warkworth		9[1])		Norfolk and Suffolk coasts
			Warkworth		1[1])		Eidsbotten, Sogne Fjord, Norway
			Warkworth				
		0	Warkworth				

[1]) Post-smolt stages.

A new trap, of the same design, was constructed in the spring and this was in operation from 6. March until 2. June. Although some three hundred smolts were caught on 4. and 5. April the main run did not start until the 16. of that month after which date large numbers of smolts were caught each day until 20. May, from when onwards the numbers were greatly reduced. No further kelts were caught after a spate which occurred on 18. May.

Altogether 7,291 sea trout smolts and 7,313 salmon smolts were tagged and the left pelvic fin of each tagged fish was clipped. In addition, all these smolts were measured. The usual numbered blue celluloid tag with a silver wire attachment was used on the salmon, but a selection of the different coloured celluloid tags used in previous years was employed on the sea trout. In addition, about 2,000 of the sea trout smolts were tagged with small serially numbered silver plates of the type used on this experiment some years ago, as these silver tags had appeared to produce significantly better results than the plastic type.

A total of 279 sea trout kelts and 24 salmon kelts were caught, and all but two of these were examined and released untagged. These two fish had Lea tags still attached and they had been tagged as kelts on the trap in April 1955.

In Tables 2 and 3 are listed the salmon and sea trout, respectively, recaptured during the 1957 season up to 31. October 1957. All the fish were tagged on the trap in the River Coquet at Warkworth, Northumberland.

A. Swain, W. G. Hartley

Salmon Stocks

The only collection of scales received this year has been from the Northumberland and Tyneside River Board. On this occasion the information sent with the scales has been complete, instead of just a note of the weight, so that accurate measurements have been possible, but the forty-nine salmon sampled included twelve which had been tagged by us and recaptured, and for which the data were, therefore, already available.

Records of the smolt ages and adult age-groups over the past six years are as follows: —

	Number in	Smolt age in years (%)			Sea age-group (%)					
Date	sample	1	2	3	1+	2	2+	3	3+	SM
1957	49	16	84	0	16	37	33	6	6	2
1956	66	11	86	3	15	32	35	6	6	6
1955	29	10	90	0	36	3	55	3	3	0
1954	92	10	85	5	27	23	36	8	1	5
1953	82	2	89	9	10	29	37	7	0	17
1952	78	13	86	1	17	33	35	9	0	6

These figures call for no special comment; the apparent rise in the proportion on one year-old smolt histories does not reflect a real increase in one year, as the catch in any one year represents several years smolt migrations. The sea age-groups are normal in their proportions, which indicates that sampling has been reasonably uniform.

Salmon and sea trout caught at sea

Information on sea trout caught by trawlers continues to arrive, and data on 74 untagged sea trout have been received this year, compared with 51 last year, and 43 in 1955.

Twenty-seven of the fish were caught on 7. to 8. June, 45 miles N.E. by N. of Smith's Knoll lightvessel, in 17 fathoms, and five more in the same area and depth on 20. July. Substantially all the fish come from the Leman and Botney grounds (about 55°30′ N., 2°30′ E.) with a few from some thirty miles North.

An interesting fish shows a scale reading of 1+.1+; this is the only sea trout in our experience to show a one-year parr history. The calculated lengths are 10 cm. at 1 year, 15 cm. as a smolt, and 33 cm. for the first sea winter.

Sixteen of the fish caught on 7.—8. June were 2.1+ or 2+.1+ years old, and three of these showed a spawning mark. The rest are older, and show considerable variation in size and growth-rate.

A descriptive paper on the material already available will be prepared when the anylysis is complete.

W. G. Hartley

Research on Osmoregulation in Salmon

Work on this problem has developed along three related lines. Firstly, analyses of some inorganic constituents of blood have been made on salmon (*Salmo salar*) at different times during the freshwater and marine life. Secondly, a study of salinity tolerances is being made with salmon (*S. salar*), brown trout (*S. trutta*), and rainbow trout (*S. irideus*). Thirdly, histological preparations of the gill tissue of these fish in fresh water and salt water are being prepared and studied. These three lines are interrelated in that they all show some aspect of osmoregulation in the fish.

Blood of parr (1 year +) and smolts (2 years +) in fresh water, smolts in tidal and sea water, and adult fish in sea water, has been analysed for sodium, potassium, and chloride content, and these results correlated with estimates of freezing-point (and thus total ionic concentration). Some estimates have also been made for the blood of brown trout and rainbow trout. Analyses of both whole blood and plasma have been made for the larger fish, so that an estimate of the partition of the ionic constituents between corpuscles and plasma can be made. During the freshwater life of the fish, the blood increases a little in its total concentration between the time of hatching and the fry stage, but after this it remains relatively constant. When smolts migrate into sea water or tidal water there is no immediate sharp increase in the total concentration, but a slow rise (incomplete in 2 weeks of a sea-water environment) to the level of the blood of adult salmon in sea water. On the other hand, the sodium and chloride in the blood are much more sharply increased during the transference from fresh to sea water, so that some non-electrolyte may change in a compensatory manner. Potassium concentrations show a decline during this transference, but these ions are not numerically important during the change.

In adult fish in sea water, the chloride and sodium concentration are reduced, so that their increase during the migration is a temporary one. Analyses of the blood of brown and rainbow trout in fresh water are similar to those of smolts in fresh water and to those published for other freshwater teleosts.

Experiments to demonstrate the tolerance to salinity changes have been made with salmon, brown trout, and rainbow trout of different sizes and different ages. Fish are transferred from their normal freshwater environment to media of various sea-water strengths ($^1/_4$ s.w., $^1/_2$ s.w., $^3/_4$ s.w., and s.w.) and the survival of the fish and changes in the total blood concentration measured. From the preliminary results, it is clear that tolerance to high salinities depends rather on the size of the fish than on age or species. Thus large rainbow trout survive high salinities better than do small salmon. But young salmon tolerate a little better than do rainbow trout of the same size range. There is some indication that while rainbow trout may tolerate high salinities well, their adaptation to salt water is not so good as that of young salmon. Thus some fish will survive direct transfer to full strength sea water, but die after a week in the medium.

The histology of the gill tissue is being studied in order to relate this to the development of regulation. Good methods of fixation and staining have had to be developed for this work as it is clear that this tissue requires special treatment. The identification of the salt-regulating cells between the gill lamellae is now relatively simple with the use of the correct technique. A comparative study of these cells in salmon of different ages and in brown and rainbow trout is being made. It appears from this study that the salt-regulating cells are well developed in large fish of any of these 3 species, but that they are present only in very small numbers in young salmon parr. Methods of estimating the numbers and activity of these cells are now being investigated.

Gwyneth Howells

Germany

Salmon Catches, 1956–1957

(Figure 1; Table 4)

The increase in the yield of the German salmon fishery in the south-eastern part of the Baltic continued in 1957 and resulted in a total catch of 345 tons, against 286 tons in 1956, and 157 tons in 1955. Within four years the annual yield has quadrupled, the average landing per trip increasing from 342 kg. in the season of 1952/53 to 696 kg. in 1957. As predicted in the last report, the season 1956/57 has brought a record yield of 375 tons, which as yet has never occurred in the German salmon fishery, and is nearly double of the best fishing seasons of 1950/51 (196 tons) and 1954/55 (195 tons).

Very good catches obtained in November/December 1956 and lasted into January 1957. After a decline in February, March showed a rise of the landings, and still in May, some good catches were made by drift-nets. In the beginning of June the fishery came to an end.

After a stop of four months, the new season began in October, and the landings rapidly increased to a maximum in November and December, followed by a heavy decline in the first months of 1958.

The size composition of the landings at the Kiel fish market in 1957 is given below: —

Market category	I	II	III	IV	V
Gutted weight, kg.	>8	5–8	3–5	2–3	<2
			Number (%)		
January–February .	2.7	14.0	27.8	47.1	8.7
March–April	6.7	24.9	39.5	26.4	2.5
May–June	2.4	14.1	71.9	11.6	—
October–December .	12.9	36.5	19.0	24.4	7.2
Total catch	7.3	25.3	28.9	32.2	6.3

From the last season ending in spring until the new season began in autumn, it is possible to state a remarkable change in the size composition which is opposite to that observed in the previous year. In 1956, the proportion of large salmon (category I) decreased heavily, whereas the fish of medium and smaller size (III and IV) increased. On the other hand, in October/December 1957 the proportion of large salmon amounts to 13%, against 4% in January/May, and the next size-group (II) has risen from 20% to 36%. The proportion of the smaller salmon (IV and V) has dropped from 43% to 32%. This alteration in the size composition resulted in a considerable increase of the average weight, from 3.75 kg. in the spring to 4.88 kg. in the autumn. The average weight per year was 4.03 kg. in 1956 and 4.16 kg. in 1957,

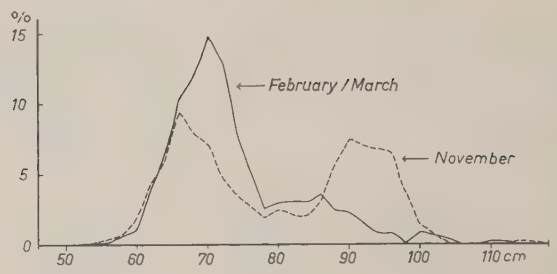


Figure 1. Length distribution of salmon caught by drift-lines in the south-eastern Baltic, February/March and November 1957.

that is altogether a slight increase. As mentioned in the last report, the appearance of many salmon of medium size (II—IV) in the season 1956/57 was caused by a rich year-class passing its second winter in the sea. In the course of 1957, the further growth of this abundant year-class could be observed, getting on to its third winter, as will be seen from Figure 1. The length distribution of commercial catches landed at the Kiel fish market in February—March shows a main maximum at 70 cm. for fish spending their second winter in the sea, and a low secondary peak at 86 cm. for fish in the third winter. In November 1957, the length curve has two maxima, nearly of the same height and separated by a broad minimum. They represent salmon starting their second and third winter in the sea, apart from some older specimens belonging to the second peak. From these measurements can be concluded that in the season 1957/58 the salmon passing their third winter in the sea, are more numerous than in the previous season. The appearance of this rich year-class in the south-eastern Baltic in the season 1956/57 caused an unexpected rise in the landings, but a decrease in the average weight of the fish; one year later, however, in the season of 1957/58, good catches partly of high quality, were taken as a result of the greater frequency of big salmon.

This statement indicates the significance of the fluctuations in the stock for quantity and quality of the catches taken in each fishing season.

Table 4 shows the quantities of each market category landed at the Kiel fish market during the last two years.

Table 4. Salmon landed at the Kiel fish market in 1956 and 1957 (in tons)

Market category	I	II	III	IV	V	Total
Jan.–June 1956 .	21.7	34.7	13.7	6.4	0.4	76.9
Oct.–Dec. 1956 ..	9.5	57.6	35.5	18.8	0.3	121.7
Jan.–June 1957 .	14.6	37.9	45.0	38.1	3.9	139.5
Oct.–Dec. 1957 ..	24.1	51.4	14.7	12.8	2.6	105.6

The landings of each market category vary in a characteristic manner. The appearance of an abundant year-class resulted in a considerable increase of market categories III and IV in the first part of the season 1956/57, which continued in the second part, but was followed by a sudden decline in the next season when the larger size-groups I and II rose remarkably.

Thus a detailed and continued survey of the size and age composition of the catches can explain the fluctuations in the yield of the salmon fishery in the sea.

R. Kändler

U. S. S. R.

Biology and Stock Conditions of Salmon

First-time spawners enter the rivers of the Kola Peninsula debouching into the Barents Sea, at the age of 3+ to 9+ years; 7+ and older ages occur relatively rarely and the main bulk of migrants consists of fishes at the age of 4+, 5+, and 6+. Rivers flowing into the Barents Sea within the boreal region are entered mainly by fishes that spawn in the year of entry ("summer" type), whereas further southward and in the rivers of the White Sea comparable numbers of "summer" and "autumn" types or prevalence of the latter occur. In most shallow rivers flowing into the White Sea fishes at the age of 4+ and 5+ constitute the majority of the migrants.

In most cases the majority of the young fish spend three years in river waters before descending into the sea; two-year-olds are observed in dominant numbers in several rivers flowing into the White Sea: here the young fish descending at the age of 4+ and 5+ occur much more rarely than in the rivers of the Barents Sea.

If we take the mean value of salmon catches in the rivers of the Kola Peninsula in 1926 to 1930 for 100%, then the average values of the catch for subsequent periods will be as follows: —

1931/1940 — 195%
1941/1950 — 195%
1951/1957 — 175%

It is seen from the above that no decrease in the catches was observed during the last 30 years. Such stable catches are the consequence of proper regulation of the fisheries and application of protective measures.

I. I. Lagunov, V. V. Azbelev

Shellfish

CRUSTACEA

Norway Lobster in the Skagerak and Northern Kattegat

(Figure A; Tables 1–4)

Yield of the fishery

The total yield of Norway lobster in the Skagerak and Kattegat has, on the whole, showed a considerable increase. In the beginning of the thirties the total annual yield was about 200—300 tons and was taken almost exclusively by Sweden. In the late thirties the yield was about 1,000 tons, Denmark's part being slightly more than half of this amount. During most of the war the catch was lower, but from 1944 to 1954 it fluctuated between 1,000 and 1,400 tons annually. In 1955 the yield rose to 1,800 tons, mainly on account of a leap of the Danish catch from 520 tons in 1954 to 1,013 tons in 1955. In 1956 and 1957 the catches amounted to 1,469 and 1,638 tons respectively.

The reason for the increasing yield is mostly due to an intensification of the fishery, but the large yield in 1955—56 is, however, partially due to the reduction of the Danish minimum size from 160 to 150 mm. The minimum size of 160 mm. was put into force in Denmark as from January 1936; in Norway and Sweden the minimum size was 150 mm. as from the introduction of the convention of 1952.

Length composition of the stock

The percentage length distribution of the catches, smoothed for three years, taken by the research vessel "Biologen" in the northern Kattegat in May—August is shown in Table 1 and Figure A.

From the three curves on the left hand side the decrease in number of lobster as regards size (indicated for each cm.) over the peak of the curves may be observed, the curves for the fifties being much steeper than that for the thirties. The change is parallel to the change in the fishing intensity which has increased very much since the thirties when the stock was rather lightly exploited.

In order to make a clear illustration of the difference in reduction of the numbers of males in the 15—80 m. depths the length of 14 cm. has been fixed to 100 in Table 2.

The reductions from the peak have been shown on the right hand side of Figure A.

Table 1. Length distributions (nearest lower cm.) of Norway lobster in catches from May–August in the northern Kattegat at a depth of 15–80 m.

cm.	Males			Females		
	1935–39	1949–54	1955–57	1935–39	1949–54	1955–57
6	—	—	—	—	—	0.6
7	—	—	0.2	1	0.6	2
8	0.3	—	1	3	2	6
9	1	1	2	6	6	10
10	3	3	5	10	12	16
11	6	6	7	14	20	18
12	9	11	12	18	20	20
13	12	15	16	18	17	14
14	13	18	19	14	10	7
15	12	16	16	10	.7	3
16	10	14	11	5	4	2
17	10	9	6	2	1	1
18	8	5	3	0.2	0.4	—
19	6	2	1	—	—	—
20	3	0.3	0.3	—	—	—
21	2	—	—	—	—	—
22	1	—	—	—	—	—
23	1	—	—	—	—	—
24	0.4	—	—	—	—	—
25	0.2	—	—	—	—	—

Table 2

	Length (cm.)										
	14	15	16	17	18	19	20	21	22	23	24
	Number of specimens										
1935–39	100	89	79	72	62	48	25	17	9	1	1
1949–54	100	92	76	51	30	10	1	—	—	—	—
1955–57	100	84	64	29	15	5	1	—	—	—	—

In the Skagerak about 10—20 miles N. x E. of the Scaw at a depth of 150—230 m. the stock is much more dispersed and the fishing for Norway lobster is much less intense. Actually the Norway lobsters here are only taken occasionally in connexion with the fishery for the deep-sea prawn. Here the curve of the decrease in number of the Norway lobsters over the peak is less steep than that for the northern Kattegat. The length distribution was as indicated in Table 3.

Also in the Skagerak the commercial value of the stock has decreased throughout the years, but less than in the intensively fished northern Kattegat. In recent years the catches from the "Biologen" have been so small that the period 1948—57 cannot be devided into two groups.

The figures clearly show that the fishing affects the stock to an increasing degree by removing a considerable part of the lobsters over the size limit.

The length of Norway lobster in various areas

The mean lengths in 1955/57 in different areas are shown in Table 4. In the northern Kattegat most of the Norway lobsters are found at a depth of 35—80 m. on the edge of the Ålbæk shallow, and here the mean size is smaller than at lesser depths. A few, mostly larger males, stray into a depth of 15—35 m. A similar large mean length as that at a depth of 15—35 m. is encountered north and north-west of the Scaw at a depth of 60—110 m. The mean length in the deep Skagerak N. x E. of the Scaw is somewhat smaller, and the smallest mean length is found off Lysekil at a depth of 60—100 m.

On the edge of the Ålbæk shallow the fishermen must reject about 78% of the lobster caught if the size limit is 150 mm., and 92% if the size limit is 160 mm. when fishing with 18 mm. meshes in the cod-end. Danish investigations of the selectivity of different mesh sizes of the cod-end only shows

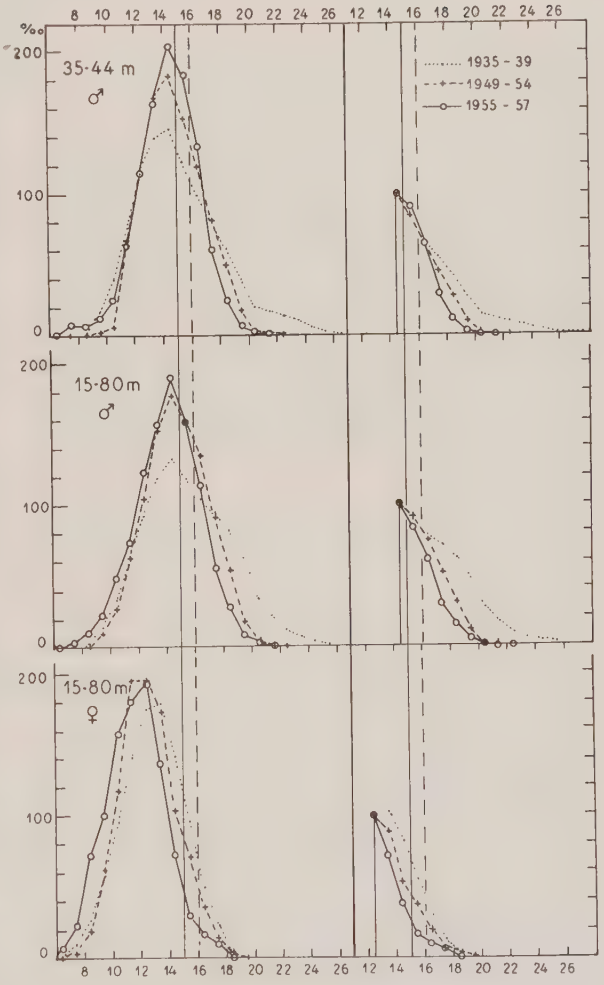


Figure A. Left hand side: Length distribution (‰) of Norway lobster in catches from the northern Kattegat at 35–44 m. and 15–80 m. depth. Right hand side: Percentage decrease of the number of the same males of Norway lobster over 14 cm. and of females over 12 cm. length.

Table 3

	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	cm.
1935–38 ..	—	—	1	3	3	5	8	11	10	11	11	9	7	5	5	4	3	2	2	spec.
1948–57 ..	1	1	2	3	5	8	9	10	11	11	9	9	5	4	2	0.7	0.7	0.2	←	spec.

Table 4. Mean length in cm. of Norway lobsters from different grounds in the northern Kattegat and the Skagerak in 1955–57

(The number of lobster measured is indicated in brackets)

	Depth, m.	July–August	November
Northern Kattegat	15-34	15.8 (88)	15.9 (62)
	35–44	14.5 (178)	14.5 (360)
	45-80	13.7 (359)	13.7 (1278)
N. and N.W. of the Scaw	60–110	— —	16.0 (228)
Off Lysekil	60–110	— —	12.6 (357)
Eastern Skagerak	150–230	14.9 (115)	— —

a small effect with 30—35 meshes, as used by the Danish fishermen. It seems that most of the undersized lobsters are rejected whilst still alive.

Some 30—50 years ago many fishery biologists were of opinion that the size limit ought to be so high that the fish or other animals caught had been allowed to spawn at least once. Naturally, it will affect the fishery unfavourably if the animals are fished before spawning, but it is fully at random to give them a respite of one year. The fishery might be exposed to losses in spite of such a size limit. The fewer animals which are allowed to spawn the less is the amount of fry under identical natural conditions and if the stock is not so large that the growth of the animals is hampered by food competition.

The protection of the females against fishery (see Table 1) must be of great value, as they may thus be able to produce a maximum amount of fry provided that the fishery leaves enough males for the fertilization of the females.

From Tables 3 and 4 it may be observed that the decrease in number from one cm. group to the next was surprisingly small in the thirties when the fishery intensity was small, considering the small growth. According to the observations made by Dr. HÖGLUND the annual growth at the length of 15—17 cm. is not much more than 1 cm. a year. From the tables it may be seen that the fish were only reduced by about 15% a year in the thirties when the fishery intensity was comparatively small, and the natural mortality being the main factor of the reduction of the stock.

When the natural mortality is so small it is certain that a reduction of the size limit of the Norway lobster will mean a loss to the fishery, whilst an increase will be profitable.

AAGE J. C. JENSEN

MOLLUSCA

Oyster

Larvae and Spatfall of Oysters in the Oosterschelde (Netherlands) in 1957

(Figure B)

Since reliable spatfall forecasts are a valuable asset to the oystermen aiming at a high degree of efficiency in spat collection, we continued our observations on the number and size of oyster larvae in the water of the Oosterschelde in the year 1957. The methods used in collecting samples of 100 litres of water and in counting and measuring the larvae in such samples have been described previously. The samples were again collected at the Yersche Bank station, in the centre of the Basin of the Oosterschelde. Daily samples were taken at high slack water from 14. June up to 22. June inclusive; twice-daily samples, at high slack and low slack water, in the height of the season from 24. June up to 9. August inclusive. From 10. August up to 31. August samples have been collected at high slack water only. It was impossible to collect plankton samples on Sundays when our boats stayed in port. When two samples were taken a day, the average number of larvae of each size-class has been computed for 100 litres, and is depicted in the diagram (Fig. B). The intensity of setting was measured in the usual way by exposing 3 lime-coated glass slides, measuring 13 x 18 cm., at an angle of 45° in a concrete container for periods of 3 days. The average number of spat per slide is shown in the diagram. The average number of barnacles (predominantly *Elminius modestus* Darwin) found on 10 cm.² of the slides (5 cm.² upper plus 5 cm.² lower surface) has also been depicted in the diagram.

Again, we predicted that the total number of larvae to be produced would be so great that

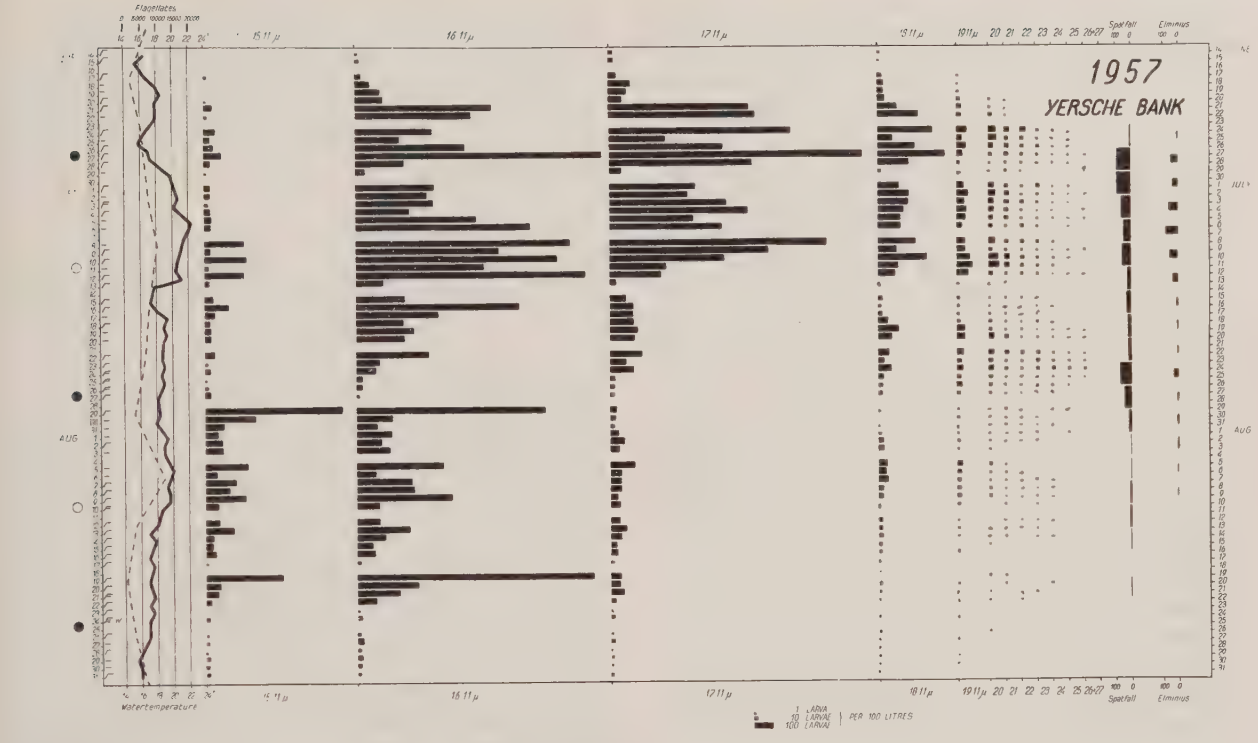


Figure B.

only exceptionally low water temperatures or a serious deficiency in the number of suitable flagellates would lead to disappointing practical results. Huge numbers of larvae were expected to appear late in June already, so that under otherwise favourable conditions setting of commercial magnitude could be anticipated early in July.

Early spring had been rather mild, with water temperatures 1.2°C. above the average in January, 2.5° in February, 2.7° in March, and 3.4° in April. But then a prolonged spell of cold weather led to a considerable retardation of the warming up of the water: in the month of May water temperatures were 1.5° too low, and in the first half of June 1.1° below the average, whereas the second part of June gave the normal figure, viz. 17.4°C. No delay or speeding up in the production of larvae was to be expected from these deviations from the normal course of temperature.

In the first bulletin, issued 20. June, it was stated that over 200 larvae had already made their appearance per 100 litres of water, but as "umbo" and "mature" larvae were failing thus far, no setting at short notice could be anticipated. On 25. June a rapid increase to figures up to 1000 larvae per 100 litres of water was recorded, together with a favourable development of the larvae produced earlier. A drop in water temperature made the outlook for spatfall, however, uncertain. On 28. June it was said that great numbers of oyster larvae could be observed in the Oosterschelde, and that larval development was good; "umbo" larvae increasing in numbers and the first "mature" larvae having been observed, spatfall of commercial importance was announced, provided the gradual increase in water temperature would continue. On 3. July it could be stated that the water temperature left nothing to be desired, and that the number of oyster larvae amounted to over 1000 per 100 litres. Still, the number of "mature" larvae did as yet not attain the level one would expect under such apparently favourable conditions. It was forecasted that setting would be no better than fair in the days to come. Information of the same character was broadcast on 8. July. As no further rise in the number of "mature" larvae could be observed, setting would continue on the same level. A further increase in the number of

young and "umbo" larvae was brought to the oystermen's attention on 10. July. On 18. July it was stated, however, that a drop in water temperature and in the number of "mature" larvae made further setting prospects unfavourable. On 25. July it was said that fair numbers of oyster larvae had been observed and that larval development was much better than before, so that the number of "mature" larvae showed a rapid increase, which would lead to a rather high setting intensity in the first days to come. Less favourable was the outlook on 31. July because of a decline in the number of "mature" larvae. No further bulletins were issued since setting prospects became poorer and poorer in the month of August.

The diagram (Fig. B) demonstrates that the total production of larvae was very great, indeed, in the year 1957. This is certainly a noteworthy fact. The size of the stock of oysters did not differ noticeably from that in 1956, but the condition of the oysters during hibernation was certainly much better early in 1956 than in the early spring of 1957. Though health and strength of the oysters left little to be desired in the winter season 1956 to 1957, it could not be denied that their condition index revealed a much lower figure than the year before (Ann. Biol., **13**: 236—38). It has often been assumed that the amount of glycogen stored by the oyster in its connective tissues would be of considerable influence on the number or on the viability of the larvae produced in the following summer. The fact that the 1957 production of larvae did not fall short of that in the year 1956 casts doubt on the influence of winter condition, and reveals that the material required for reproductive activities is predominantly accumulated in spring and early summer of the same year.

The diagram reveals also that the vast majority of the larvae has made its appearance in the weeks between 20. June and 15. July, and further that the larvae produced in August were of smaller size and poorer development than those liberated by the mother oysters earlier in the season.

The peaks in larval production were not very clear cut in the year 1957, but closer inspection of the diagram reveals that high numbers made their appearance about 24. June and about 6. July; peaks of lesser importance can be noticed about 5. August and 20. August. The great numbers of larvae observed on 29. July must at least partly be ascribed to the proximity of mother oysters ejecting their larvae. This can be concluded from the rather modest figures for the following days, but above all from the fact that the two samples collected on that day differed widely; from 100 to over 3,000 larvae.

It is noteworthy that the peaks mentioned above all occurred some 10 days after full or new moon. That the first peak came slightly late, corresponds with the retardation of incubation brought about by the low water temperatures prevailing at that time.

Larval development was very good late in June, and again late in July. This cannot be ascribed to exceptionally favourable water temperatures or to unusually high flagellate figures. Since we know that some species of flagellates are a much better food for oyster larvae than others, we could surmise that the quality of the flagellate stock was very good at the time of excellent larval development, but it will be hard to adduce convincing evidence to prove that this has been the predominating factor.

Setting on lime-coated glass collectors commenced as early as 24. June and revealed a peak of considerable importance between 27. June and 2. July. Surprisingly large numbers of oyster larvae settled in that period on our experimental collectors, many more than anticipated from the number of "mature" larvae, which was fair, but certainly not excessive. In the entire first half of July setting was good and on a commercially interesting level. After 12. July setting was of lesser importance, which tallies with the predictions. At the end of the month of July a second peak in setting made its appearance, which corresponds very well with the observed improvement in larval development, the greater number of "mature" larvae ensuing, and with the announcement made on 25. July.

Judging from the number of "mature" larvae only, we should, however, have expected a higher setting intensity late in July than at the end of the month of June. It is not quite clear why the real figures demonstrated that the reverse was true. It follows from our observations that a plausible explanation could be derived from the fact that "mature" larvae, ready to settle and provided with an "eye-spot", were of somewhat smaller dimensions early in the season (from 22.11 μ to about 25.11 μ) as compared with late in July (from 23.11 μ up to 27.11 μ), which makes it somewhat difficult to read from the diagram with exactitude which setting intensity is to be expected. It must be remarked that the newly liberated larvae were, on the other hand, of larger dimensions early in the season than late in July.

Commercially the spatfall season was successful in the year 1957. Both the 2,000,000 lime-coated

tiles and the 10,000 m.³ of mussel shells scattered on the deeper plots caught a good set of spat.

The setting of barnacles showed a peak late in June and early in July, which coincided with the oysters' spatfall.

P. KORRINGA

The Quality of Oysters in Relation to Environmental Conditions in the Oosterschelde in 1957

(Figures 1–11)

In the year 1957, observations on the quality of seed-oysters and marketable oysters (based on determination of the condition index throughout the growth season from June to November inclusive) were made on a limited scale in two districts of the Zealand waters.

Considerable attention was paid to various hydrographical and biological factors, presumably associated with the growth and fattening of oysters. It has been tried to get a general idea about the total system of supply and production of shellfish food in the Oosterschelde and to trace the factors which influence the oyster's nutrition. With that aim samples of water were collected (and analysed) during the months of January, February, November, and December on a fortnightly basis, and during the warmer months with intervals of a week.

The samples were taken at high slack and low slack water on one and the same day at about 1 metre depth at the Yerseke Bank station (plot 339A) in the centre of the Basin of the Oosterschelde (below briefly called "Yerseke") and at the station at the lightbuoy Engels vaarwater/Brabants vaarwater, situated between the islands of Noord Beveland, Schouwen, and Tholen, due south of the city of Zieriksee (below briefly called "Zieriksee").

At the latter station, the water of the Oosterschelde mixes, during every ebbtide, with some water from the northern district —which normally has a somewhat lower salinity than the Oosterschelde—entering the Oosterschelde through the Keeten, the channel situated between the islands of Schouwen and Tholen.

During the floodtide, part of the Oosterschelde water at the station Zieriksee is replaced by real coastal water from the western district which has as a rule a somewhat higher salinity. This is caused by the surplus of flux to the northern district taking its course through the Keeten (Fig. 1).

As the samples were collected by two different vessels, it could be so arranged that they were taken on the same day and at about the same time at each station.

Salinity

At the Yerseke Bank station, centre of oyster production, the salinities at H.W. and L.W. differed as a rule but very slightly. At the Zieriksee station, in the mouth of the Oosterschelde, where some plots for oyster relaying are situated, one can observe a distinct difference between the salinities at H.W. and L.W.

The average salinity at Yerseke was slightly lower than at Zieriksee, which difference should presumably be ascribed to drainage water from the land, which is discharged especially in the winter season.

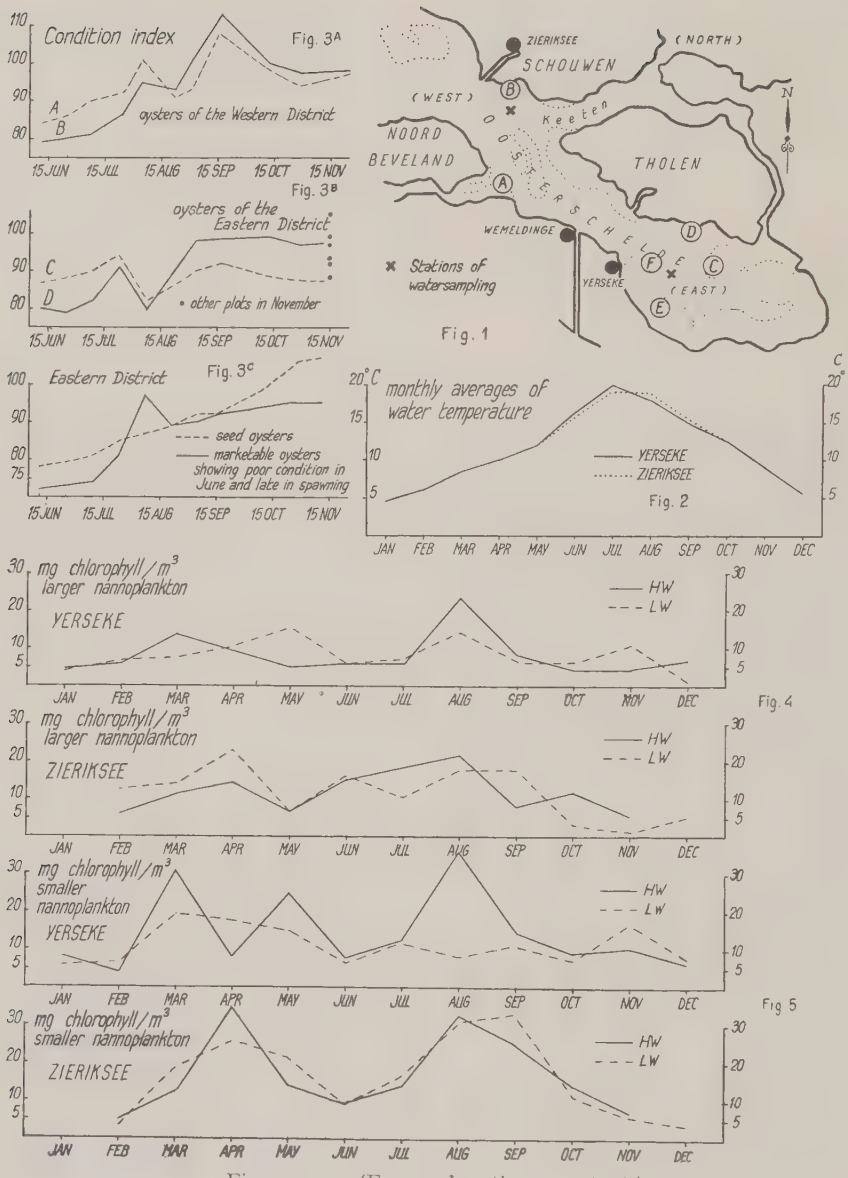
The average salinity at Zieriksee (H.W.), Zieriksee (L.W.), and Yerseke (mean of H.W. and L.W.) respectively can be expressed as follows for the year 1957:—

First quarter	:	29.10‰, 28.52‰, and 27.79‰.
Second quarter	:	29.15‰, 28.51‰, and 28.30‰.
Third quarter	:	30.43‰, 30.18‰, and 30.03‰.
Fourth quarter	:	29.71‰, 29.49‰, and 29.05‰.

Temperature

The increase of water temperature in spring and early summer was later at Zieriksee than at Yerseke and did not lead to the same high level, though the difference was not very great. In the same way the fall of water temperature at the end of summer and in autumn was later at Zieriksee (Fig. 2). This may have been the reason why the oysters spawned about two weeks later in the western district than in the Basin of the Oosterschelde (eastern district) as indicated by the steep drop in the condition index, in the first half of August and in the second half of July respectively (Fig. 3A and B). On the other hand, the somewhat slower decrease in temperature in autumn may have contributed to the continuation of the higher phytoplankton level in the western district during September. But, besides, the phytoplankton consumption level was lower at Zieriksee than in the densely populated Basin of the Oosterschelde. The oyster condition indices in the eastern district, measured in September, did not reach the figure 100, whereas the oysters in the western parts revealed figures of 105 and over. Generally speaking, the monthly averages of the water temperature were well above those of several foregoing years.

At Yerseke L.W. temperatures surpassed those at H.W. in spring, whereas H.W. temperatures



Figures 1-5. (For explanation, see text.)

were higher there in autumn, which demonstrates the greater influence of weather conditions in the shallower eastern district.

Phytoplankton

As has already been mentioned, there was a marked difference in the phytoplankton stock between Zieriksee and Yerseke, but this was not only the case in September. The differences were estimated by determining the chlorophyll concentration in mg. per m.³ contained in various fractions of the plankton:—

(a) *net plankton*, measuring over 55 micron;
(b) the *larger nanoplankton* organisms, with dimensions between about 15 and 55 micron; and
(c) *small nanoplankton* organisms measuring less than 15 micron, which latter fraction may contain excellent oyster food. These fractions are acquired by using bolting silk No. 25, quick soft paper filters, and membrane filters respectively, and by subsequent subtraction of the figures obtained.

(a) The net-caught plankton at Zieriksee showed no difference worth mentioning between H.W. and L.W. The basal quantity of chlorophyll in this

fraction amounted here to 5—10 mg./m.³. There have been two major peaks. The first in the months of April and May with mean concentrations of 25 and 17.5 mg. respectively, and the second in the months of August and September with mean concentrations of 27.5 and over 40 mg./m.³, respectively. Normally the chlorophyll content of the Yerseke net plankton at H.W. surpassed that at L.W. The basal quantity of chlorophyll at Yerseke was usually somewhat lower than at Zieriksee. During the months of June and July the average concentrations did not reach 5 mg. of chlorophyll per m.³. At Yerseke too we observed two periods of a higher chlorophyll concentration, viz. in April and May, with 17.5 and 15 mg./m³. respectively and in the months of August and September, likewise rising to some 17.5 mg./m.³, followed by October and November with 14 mg./m.³. A somewhat prolonged maximum which did, however, not reach the high figures observed at Zieriksee!

The stock of net plankton at Yerseke is based on penetration of phytoplankton with the tidal streams from the western coastal district. Evidently, a considerable part of this material is eliminated on its way from west to east, partly through grazing but no doubt also by settling, caused by the locally low current velocities in the Basin of the Oosterschelde.

(b) The seasonal fluctuations in the amount of chlorophyll contained in the larger nanoplankton organisms are shown in Figure 4. In spring the larger nanoplankton outburst at Zieriksee reached its highest concentration in the L.W. samples collected in the month of April, viz. 22.5 mg./m.³ of chlorophyll, followed later in the year (July and August) by a period with higher concentrations in the H.W. samples, averaging some 20 mg./m.³. Next followed a gradual decline to an average amount of about 5 mg./m.³, both at H.W. and at L.W., in November.

If we compare Yerseke with Zieriksee, we see that the fluctuations in chlorophyll content do not correspond very closely. The L.W. curve for the larger nanoplankton at Yerseke follows rather closely the L.W. curve for the net-caught plankton at the same station.

The H.W. curve for the larger nanoplankton shows a different character, especially in the first half of the year. Thereafter it follows more closely the course of the small nanoplankton organisms at the same station. This made me surmise that this latter fraction might contain the more autochthonic phytoplankton population.

In May the chlorophyll concentration of the larger nanoplankton reached 15 mg./m.³ at Yerseke L.W., against only 5 mg. at Yerseke H.W. and Zieriksee H.W. and L.W. This must be caused by a separate local bloom in the easternmost district. In summer and autumn we saw different types of fluctuations.

At least part of the larger nanoplankton organisms will be suitable as oyster food.

The somewhat slower autumn decline of the quantity of larger nanoplankton organisms at Zieriksee may have contributed to the continued increase in the oysters' condition in the western district during the month of September, which increase slowed down later and even turned into a decline in the months of October and November.

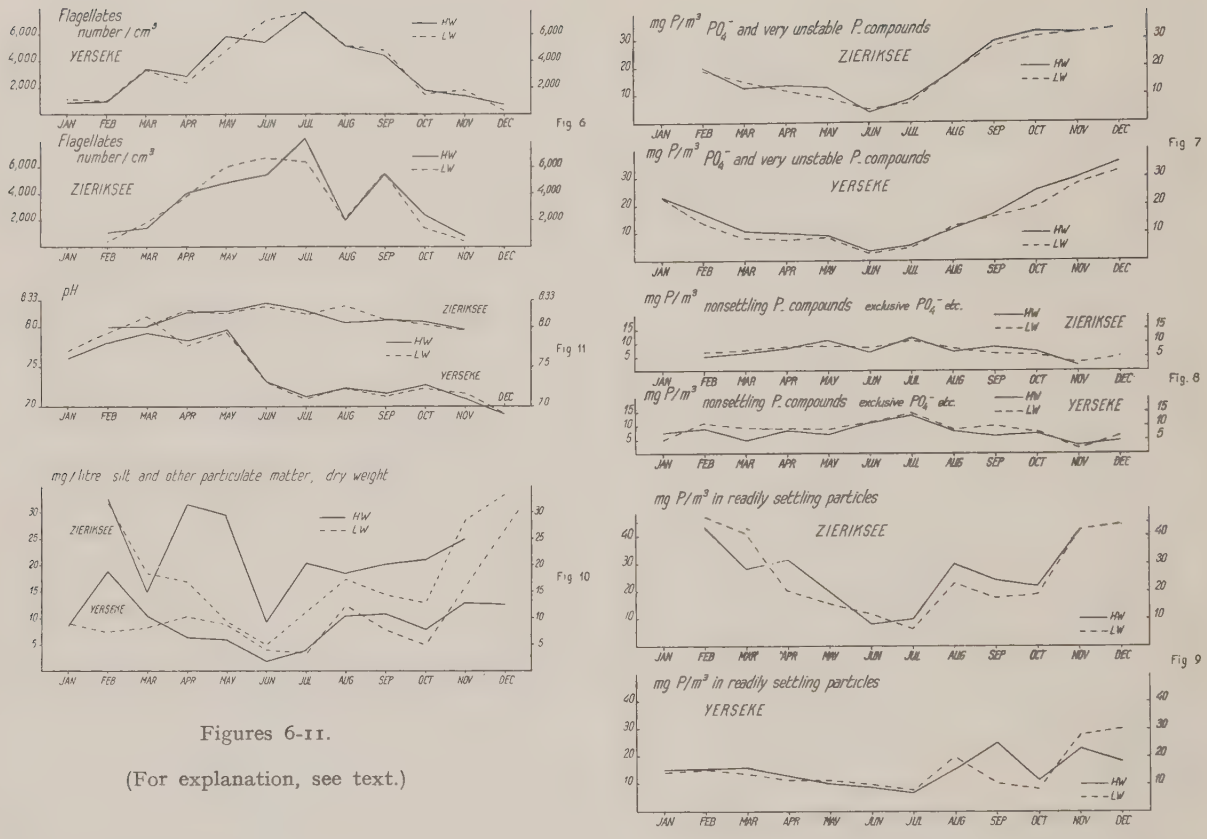
On the other hand, the increase in oyster quality in the eastern district came to a standstill, or continued very slowly only, during the month of September.

On some plots we observed a further increase in November, corresponding to a secondary maximum in the quantity of larger nanoplankton organisms.

(c) Figure 5 gives an impression of the fluctuations in the number of smaller nanoplankton organisms. At Zieriksee the curve of the related chlorophyll concentration clearly shows two peaks, just like the net plankton. The first bloom occurred in the months of March, April, and May. At H.W. the peak rose sharply to about 35 mg. of chlorophyll in April. At L.W. the mean concentrations revealed a smoother curve in these months at levels of 20, 25, and 20 mg./m.³ respectively. A minimum down to 10 mg./m.³, noted in June, was followed by a second bloom, starting in July with about 15 mg./m.³ and gradually rising to about 30 mg./m.³ in August and September, at H.W. as well as at L.W. The bloom declined in October and November to levels of 12.5 and 7.5 mg. chlorophyll per m.³, respectively.

The concentration of small nanoplankton organisms at the station Yerseke is no doubt strongly influenced by the filter feeding of the millions of oysters, which are concentrated here in rather shallow water. This could explain why the H.W. curve for this plankton only corresponds rather well with that of Zieriksee whereas the L.W. curve corresponds only in the—colder—first quarter of the year. The production of small nanoplankton organisms at the station Yerseke may even have been somewhat greater than at Zieriksee, but grazing by the oysters led ultimately to lower chlorophyll figures.

This is indicated by the fact that the phosphate-phosphorus level, especially in summer, was on an average lower at Yerseke than at Zieriksee, presumably through a more intensive phosphate exhaustion.



Figures 6-11.

(For explanation, see text.)

At Yerseke L.W. the concentration of nanoplankton chlorophyll started for the smaller organisms with 5 mg. in January and rose to some 20 mg. in March, just as at Zieriksee. The temperature was at that time too low for active feeding by the oysters. In April, however, water temperatures fluctuated around 10°C., and made possible an appreciable feeding activity. This levelled off the increase of small nanoplankton organisms here, which phenomenon was not observed at Zieriksee with its scantier bivalve population. In April the nanoplankton concentration dropped to 17.5 mg. at Yerseke, in the month of May to 15 mg., and in June even down to 6.5 mg. of chlorophyll per m.³. Although there was a second bloom at Zieriksee later in summer, the chlorophyll concentration at Yerseke L.W. remained at about 10 mg. until the month of October. As late as the month of November, when the temperature had fallen below the 10°C. level, bringing about a serious reduction of the oysters' food uptake, the chlorophyll content at Yerseke L.W. rose again to about 17.5 mg. The H.W. samples collected at Yerseke did, however, reveal a second peak in small nanoplankton organisms. This water stays only for a few hours in succession above the densely populated oyster beds. Its lower phosphate level apparently was no limiting factor counteracting this bloom.

At the station Yerseke the profuse development of small nanoplankton was not continued after the month of August. As has been remarked in the discussion on the larger nanoplankton, the almost explosive increase in oyster quality in the Eastern district contrary to the events in the Western district had already levelled off in September. In the eastern part of the Oosterschelde the oysters generally show a slow increase in quality as they continually graze down the stock of small nanoplankton organisms.

Flagellates

Besides this phytoplankton survey based on chlorophyll measurements, we investigated the number of flagellates per cm.³ by direct counting. It is noteworthy that the graphs dealing with total phytoplankton are very different from those on the flagellate population (Fig. 6). At Zieriksee we observed a regular increment from January up to

July, in which apparent differences between the H.W. and L.W. samples were lacking. In the months of May, June and July we counted more than 5,000 flagellates per cm.^{3}; in August as few as 2,000, but in September again over 5,000; next 2,000 in October and below 1,000 in November.

At Yerseke also there was not a great difference between H.W. and L.W. samples. Only in the month of June, the L.W. samples indicated an extra flagellate bloom in the easternmost section. Could it be that the difference between H.W. and L.W. was lost in July and August through the grazing of the billions of oyster larvae? The August decline in the number of flagellates at Zieriksee, possibly also caused by grazing zooplankton of some description, has not been observed at Yerseke. The flagellate concentration at Yerseke, which was at, or above, 5,000 per cm.^{3} from May up to September, indicates that the total production must have been very high, indeed. The results of setting of oyster spat, and that of other invertebrates, indicated that the flagellate stock was sufficient for the growth of the bulk of the larvae. It is not clear whether there was any correlation between the total phytoplankton and the number of flagellates most of which do not contain chlorophyll. It could be that the flagellates are at least partly responsible too for the decline of the phosphate level. The peak of the flagellate bloom (June and July) coincides precisely with the summer minimum in phytoplankton stocks and phosphate level.

Phosphates

The development of phytoplankton is no doubt correlated with fluctuations in factors such as light, temperature, and free phosphate, which latter is probably often the limiting factor in phytoplankton development.

In winter the plankton production was inhibited by scanty sunlight and low temperature, in summer by lack of phosphates necessary in the formation of proteins in the process of assimilation. In June the phosphate phosphorus—together with simultaneously measured phosphorus contained in very unstable phosphorus compounds—reached its minimum concentration of 5 mg. per m.^{3} In winter the phosphate phosphorus level rose to 25 mg. per m.^{3} and over (Fig. 7). Regular observation of the phosphate-phosphorus level is a tool in measuring the fertility of the water, and the potential productivity (Fig. 7).

The yearly average of the phosphate-phosphorus content at Zieriksee H.W./L.W. and Yerseke H.W./L.W. was 18.4 mg./17.6 mg. and 14.1 mg./12.5 mg. per m.^{3}. Presumably the lower level at Yerseke should be ascribed to the vigorous assimilation processes in this shallow body of water. The differences in phosphate content between Zieriksee H.W. and L.W. followed the same trend as the salinities there. Exchange of Oosterschelde water with water from the northern district—arriving through the Keeten—may contribute to the supply of free phosphates in the eastern district. The great supply of utilizable phosphorus comes, however, no doubt from the western coastal water, which enters the Basin of the Oosterschelde with the tides. There various unstable phosphorus compounds are broken down to free phosphates.

Organic phosphorus

Phosphorus present in somewhat less unstable compounds, which are not determined together with the free phosphates-phosphorus and which do neither readily settle by storing the water samples for a few hours—viz., the truly dissolved organic phosphorus compounds and phosphorus present in very finely dispersed particles—has also been determined.

The mean concentration at Zieriksee, H.W. and L.W. (Fig. 8) was 7.7 mg. P per m.^{3}, with minima in the winter months and a maximum of 12 mg. in July. The monthly averages for the H.W. samples fluctuated somewhat more than those related to L.W.

The average concentration at Yerseke H.W. was 8 mg. P and at L.W. 9.4 mg., the winter minima corresponding in time and level with those at Zieriksee, but with a higher summer maximum in the month of July, amounting to 13.8 and 14.4 mg. respectively.

Evidently the production of this type of P compounds is greater in the shallow Basin of the Oosterschelde than at Zieriksee. The phosphorus may be contained in humic substances produced by decomposing phytoplankton, which favour in their turn the development of flagellates, which also reached a maximum in July, as has been discussed above.

Particulate phosphorus

The phosphorus content of all the particles which settle readily within a few hours—including plankton organisms, silt, clay, and several types of detritus—revealed a maximum in winter (Fig. 9).

In June and July we observed a minimum at Zieriksee, H.W. and L.W. The gradual slopes of the curve down to and up from this minimum are interrupted by clear-cut peaks, the first in April,

and the second in August. Abundance of living plankton must be held responsible for these peaks.

The great maximum in winter must be due to accumulation of decomposition products, which remain longer in suspension at low temperatures because of higher viscosity, and which are more slowly broken down by bacteria because of the lower temperature. The maximum and minimum figures for this type of phosphorus were about 45 and 7.5 mg. respectively.

The graph for particulate P at Yerseke reveals a very different character. There we note only a slight increase in the P content in March reaching about 15 mg., and brought about by the phytoplankton, next decreasing slowly to 7 mg. in July. Particulate matter other than phytoplankton did not interfere noticeably, as far as we can see. The increment in late summer and autumn has the same background. Only at the end of the year the rough weather, whirling up bottom deposits, contributed materially to the observed maximum in the particulate phosphorus. Still, this maximum did not attain more than 30 mg. at L.W. and about 20 mg. at H.W., this in contrast to the high concentrations measured at Zieriksee. Evidently, the bulk of the material present in the western area settles before it reaches the eastern district.

Dry weight of suspended matter

The graphs of total dry weight of all the particulate matter collected with a paper filter—including organisms, detritus, silt, clay, and sand—reveal a very similar picture (Fig. 10), with the exception of the H.W. curve for Zieriksee.

The somewhat irregular course of this latter graph is ascribed to transport of inanimate material such as sand grains. At Yerseke the heaviest transport of sand and the like has occurred during stormy weather and rough sea (February H.W., wind W; December L.W., wind E).

The mean weights of "silt" during the year 1957, at Zieriksee H.W./L.W. and at Yerseke H.W./L.W., respectively, were as follows: 22.4/16.7 and 9.1/8.5 mg. per litre. Since the concentrations of total phytoplankton-chlorophyll recorded in the same sequence were 45.4/46.2 and 36.3/30.4 mg./m.^{3}, it is clear that at Zieriksee H.W. at least about 10 mg./l. and at L.W. at least about 4 mg./l. of the "silt" cannot be ascribed to phytoplankton.

Since the concentrations of particulate P were in the same sequence 26.0/24.7 and 14.6/13.6 mg., it is also clear that at Zieriksee H.W. at least about 6 mg. and at L.W. at least about 1.5 mg. of the "silt" cannot be attributed to the existence of particles containing P, but must be ascribed to inanimate material, such as sand.

The true composition of the Oosterschelde "silt" is still a theme of further investigations. The low "silt" content at Yerseke must be considered a favourable factor for the food uptake of the oysters. The low figures at this station can be ascribed to more stable bottom conditions, to lower current velocities in this district, and further to a greater amount of shelter. Besides the determination of the "silt" content by weighing, we estimated the *relative clarity* of the water with a turbidimeter and a micro Secchi disk.

At Zieriksee, H.W. samples were invariably more turbid than L.W. samples. The greater clarity was observed in the month of June. At Yerseke we saw the greatest fluctuations, also with a maximum of clarity in June.

In general, the clarity of the water followed the same pattern as the silt graphs of Figure 10. The ratio of the clarity at Zieriksee, H.W./L.W. and Yerseke H.W./L.W. was: 5.5 : 6.2 ; 7.7 : 8.2.

Organic matter

On an average some 4.5 mg. of $KMnO_4$ were necessary per litre of water to oxidize the more labile organic material not belonging to the readily settling particulate matter. Here we found the same trend as with the unstable P compounds, viz. a maximum in July. The yearly averages in the usual sequence were respectively 4.1 (max. 5.4), 4.3 (max. 6.0), 4.7 (max. 6.0), and 4.8 (max. 6.2).

The labile organic matter present in the readily settling material could be broken down by using slightly over 1 mg. of $KMnO_4$ per litre. The averages for this fraction were 1.5/1.6 and 1.1/1.2 respectively. At both stations the variations were quite irregular, with alternation of the higher figures at H.W. and L.W.

pH

The difference in pH between Zieriksee water and that at Yerseke was very remarkable. At Zieriksee pH was about 8.00 during the winter months, with a maximum of 8.30 at H.W. and 8.26 at L.W. in June, and yearly averages of 8.10 and 8.12, respectively (Fig. 11).

At Yerseke we found, however, a sharp decline from 7.96 in May to about 7.20 in June and July, on which low level it remained till the month of November. The cause of this phenomenon is still in study. We are thinking along the lines of calcium-uptake by growing oysters. Therefore we started to measure the specific alkalinity.

Oyster quality

In the eastern part of the Oosterschelde oysters were sampled at regular intervals from 4 plots (Fig. 1: C, D, E, and F), and in the western part from 2 plots (Fig. 1: A and B). At the end of the season we completed the picture with some more samples from the eastern district.

The tendency of the oyster quality, expressed as condition index, is considered characteristic for the local population. The general results are discussed above in the section dealing with the phyto-plankton-chlorophyll concentrations. The salient point is the rapid recovery after the mid-summer drop in condition, leading to minimum figures in August. Within one month the quality of the oysters exceeded that attained just prior to reproduction. Evidently, the oysters could take advantage of the excellent feeding conditions at that time of the year. Only on the shallower plots of the Yerseke Bank did the condition continue to increase noticeably in October and November. At last, the gills of the oyster in this area revealed a green tinge, which may have been caused by a *Navicula* bloom coinciding with a lowered circulation and excretion of the oysters.

The seed oysters on plot 220YB did not reveal the characteristic drop in condition through reproductive activities. This decline is also of lesser importance and later incidence where the oysters were initially of a rather poor quality (Fig. 3C).

Though the year 1957 cannot be called exceptionally good, the consumption oysters shipped in the season 1957/1958 were of good or fair quality.

These observations on oysters taken from the plots of the oystermen were supplemented by studies of oysters attached to baskets of wire netting, suspended at about 2—3 metres depth from floating light-buoys, which are anchored in several places in the various districts. The influence of the character of the bottom is eliminated by this system.

From these observations we can deduce that the production of food in the Zandkreek, south of Noord-Beveland, must have been more than satisfactory. Our suspendend oysters attained a very good condition there.

The investigations carried out in 1957 made it possible to give a plausible explanation of seasonal fluctuations in the quality of the oysters, based on analyses of water samples. We are, however, aware that local aberrations from the general course exist and we hope to get a better insight into the causative factors of these deviations by paying more attention to the peculiarities of the bottom deposits on the plots. Elimination of this influence through comparative tests with suspended oysters will presumably assist a great deal in our efforts to gain a clearer insight in this intricate matter.

We hope that our knowledge will ultimately increase sufficiently to enable us to predict growth and fattening of oysters from analyses of water samples and bottom deposits.

A. C. DRINKWAARD